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A Hindu decimal ruler of the third millennium

When I wrote my query no. 57 concerning early decimal instruments (*Isis* 24, 432, 1936) I was thinking only of instruments which might have been made and used in the seventeenth or eighteenth centuries as a consequence of the Stevinian discovery of decimal fractions (see my article on the subject in *Isis* 23, 153-244, 1935). It is interesting to realize that such an instrument was already available in ancient India and that the decimal system of weights and measures was *partly* anticipated in at least two Asiatic countries (1) by some fifty centuries.

It is now fifteen years since the Mohenjo-daro civilization was discovered (1921) (2), and our knowledge of Hindu culture was thus considerably extended. That civilization flourished in the Indus valley not only in Mohenjo-daro but in other sites such as Harappa (3) as early as the beginning of the third millennium and possibly earlier still. The dating is depending on synchronisms with the civilization of Elam and Sumer in the Mesopotamian valley.

An elaborate revelation of the Indus culture, which astonished the whole world, was given by Sir JOHN MARSHALL and his collaborators in the three splendid volumes : *Mohenjo-daro and the Indus civilization* (London 1931). The excavation of those sites has been continued as much as the financial depression made it possible, and in 1934, Mr. ERNEST MACKAY was able to report the discovery of a part of a ruler decimally divided. I quote his own words taken from his paper in the *Journal of the Royal society of arts :*

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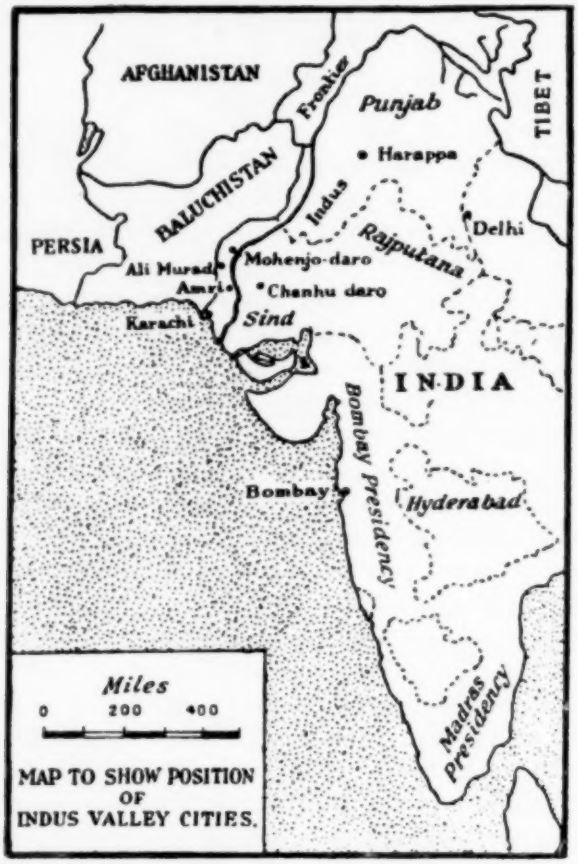
(1) The other country being the land of Sumer (*Isis* 23, 163, 167, 209).

(2) *Isis* 23, 269.

(3) See map reproduced from ERNEST MACKAY's *The Indus civilization*, London 1935, with kind permission of the publishers, LOVAT DICKSON LTD.

... "I must include in this rapid survey two most unusual objects that were found during the last season's work. The first is perhaps the most interesting object of all that we have found. It is an incomplete slip of shell, now 2'6 inches long, on which very carefully spaced lines were incised. It is evidently part of a longer measure on the decimal system, that was made in segments which were probably joined together



by metal bands. The weighted average length of one space is 0'264 inches, and the mean error of graduation 0'003 inches. Is it possible that the decimal system of measurement originated in India, as did the zero sign in later times, and that it thence spread throughout the world? In Sumer it has not yet been clearly established whether the decimal or duodecimal system was first used. From the evidence of this measure, however, it seems possible that the Sumerians derived the system from the Indus valley. I should like to add that shell was the best substance

that could have been employed for making this measure : it is a material that does not warp nor crack, and it is quite unaffected by normal changes of temperature. It may well be that the people of the Indus valley were sufficiently advanced to look for such properties in their instruments of precision " (p. 222).

In his book of 1935, he adds

" Probably, in its original state the complete scale consisted of many pieces joined together by metal bands, and the choice of shell for this purpose was an excellent one... It is certain that the decimal system of notation was also practised outside India at this time, or even earlier, as it occurs on the Proto-Elamite tablets and on others from Jemdet Nasr in Mesopotamia " (p. 136).

Further information on decimal ideas in the Indus valley might be obtained from the examination of their system of weights. From Sir JOHN MARSHALL's work, chapter XXIX, *System of weights at Mohenjo-daro* by A. S. HEMMY (vol. 2, 589-98), I extract the following conclusion :

" A system of weights has been therefore discovered which is identical in Mohenjo-daro and Harappa. These weights are with hardly an exception uniform in shape, a rectangular block, cubical in the smaller sizes, and in the great majority of cases of the same material—a hard chert. They are well finished with polished faces and occasionally with bevelled edges. They are made with much greater accuracy and consistency than those of Susa and Iraq.

The system is binary in the smaller weights and then decimal, the succession of weights being in the ratios 1, 2, 1/3 × 8, 4, 8, 16, 32, 64, 160, 200, 320, 640, 1.600. There is no evidence of a sexagesimal system, but between 1 and 32 we find a similar succession of ratios at Susa. The most frequently discovered weight, of ratio 16, has a mean value 13.71 gm. = 211.5 g. t., which shows no relation to the Babylonian shekel or its double. (4)

No inscription nor mark of value has been found on any of the weights. It is therefore probable (unless marks were originally painted on) that

(4) Sir FLINDERS PETRIE has pointed out that this value comes within the range of the *beqa*. Egyptian weights of various designations, however, can be found of almost any value between 7.5 gm. and 14.25 gm., so that equality with one or another is more likely than not to occur; but the fact that the *beqa* is one of the earliest Egyptian weights may give some significance to the coincidence.

commercial transactions took place between classes of people who were completely ignorant of reading and writing" (p. 596).

It is thus clear that the decimal ideas of those early Hindus, as well as those of the Sumerians, were not pure; they are nevertheless very remarkable. We must humbly remember that our own system is not absolutely consistent (5), not to speak of the barbarous system which still obtains in the Anglo-Saxon world.

A final remark : It has not yet been possible to decipher the script of the Indus Valley, though a great many signs have been isolated and classified. That early script is in all probability connected on the one hand with South Semitic and Phoenician scripts and on the other with the Brahmi and Sanskrit alphabets. The numerical system is still doubtful (S. LANGDON, in MARSHALL, vol. 2, 412).

BIBLIOGRAPHY

1. Sir JOHN MARSHALL : *Mohenjo-daro and the Indus civilization* (3 large quarto vol., London 1931; *Isis* 19, 574).
2. ERNEST MACKAY : Further excavations at Mohenjo-daro (*Journal of the Royal society of arts*, vol. 82, 206-24, 1934).
3. ERNEST MACKAY : *The Indus civilization* (210 p., 16 pl., London, LOVAT-DICKSON, 1935). Excellent popular account.
4. GUY RATCLIFFE HUNTER : The script of Harappa and Mohenjo-daro and its connection with other scripts (London 1934; *Isis* 24, 257).
5. BIBHUTIBHUSAN DATTA and AVADHESH NARAYAN SINGH : History of Hindu mathematics. Part 1. Numerical notation and arithmetic (Lahore 1935; *Isis* 25, 478-88). Contains no information on this subject.

The writing of this note was somewhat delayed because I applied on Nov. 8, 1935 to Mr. ERNEST MACKAY for the courtesy of a photograph of the decimal ruler, and waited indefinitely for an answer that never came.

Harvard Library, 185. GEORGE SARTON.
February 5, 1936.

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(5) We have never succeeded in shaking off the sexagesimal ideas of the Sumerians, and our measurements of angles and time are disgracefully complicated (*Isis* 23, 202).

The dualistic cosmogony of Huai-nan-tzŭ and its relations to the background of Chinese and of European alchemy

Alchemy appeared in China about the third century B.C., at a time when Taoism, which had previously been a pure metaphysics, took on magical and fantastic connotations and practices and became an important religion. Its objectives had a natural affinity with the aims of Taoism. Its followers were Taoists. Chinese alchemy seems to have been a spontaneous and indigenous growth, conceived by the Taoists and nourished by them.

Contemporary with the beginnings of Chinese alchemy, the notions of *Wu-hsing* (12698, 4624) (1), the Five Elements (metal, wood, earth, water, and fire), and of *Yin-Yang* (13224, 12883), the Two Contraries, began to assume the importance which they have now possessed for more than two thousand years, an importance which has been due in part to their usefulness as genuine scientific concepts for the interpretation and classification of natural phenomena and in part to their innumerable occult and magical relationships by which they constitute the background, the very warp and woof, upon which Taoist thought and a large part of Chinese thought in general is embroidered. The notion of *Wu-hsing* was not at that time new. As a scientific concept, free from occult relationships, it had existed probably as early as the twelfth century B.C. The notion of *Yin-Yang* on the other hand first appeared in Chinese thought at the time of the beginnings of alchemy, and it was then already matured and bound up with occult relationships.

(1) The numbers printed after Chinese words at the point of their first occurrence are the numbers by which the Chinese ideographs are designated in GILES' *Chinese English Dictionary* (2nd. ed., London, 1912). They thus identify the words and distinguish them from others of the same romanization.

The maturity and completeness of the *Yin-Yang* doctrine at the time of its first appearance in Chinese thought suggests strongly that it was an importation. Alchemy in China, on the contrary, seems to have had a history and a growth from small beginnings —a circumstance which indicates that it was probably of native origin. Since we know of no alchemy earlier than that of China, there seems, at present at least, no place outside of China where we may look for the origin of alchemical ideas. With *Yin-Yang* however the case is otherwise. Similar doctrines had existed outside of China at an earlier date. Notions of the Two Contraries, as scientific doctrines tied up with religious and occult relationships, had existed earlier in Egypt and in Babylonia and possibly in India. They supplied a general background for scientific and for other thought and were congenial to the growth of science but supplied no special motive for the growth of any particular science. Taoism in China supplied a motive for the growth of alchemy. The dualistic doctrine of *Yin-Yang* furnished a medium in which alchemy could flourish.

Primitive science appears to have been erected—as our present science is still erected—upon the simple fundamental epistemological truth that the thing which we wish to consider must be distinguished from all else, set apart in thought, marked off from the things that we do not at the moment wish to consider for the purposes in hand. The *is so* is distinguished from the *is not so*, the *yes* from the *no*, by a process which constitutes the first step in the creation of order. The first chapter of Genesis tells that chaos in the beginning was classified by the process of separating opposites, the day from the night, the light from the darkness, until at length the four " Aristotelean " elements, air, earth, fire, and water, appeared in their proper places, the fiery firmament, the waters under the earth, etc. The chapter is austere poetry but it clearly contains an epistemologically correct account of the process by which the intelligence creates order out of the chaos of experience.

The earliest philosophies with which we are acquainted teach that the universe is controlled by or consists of Two Contraries (two contrary principles, forces, deities, or kinds of raw material for the production of substance) by the interaction of which all things in the world are produced. In Babylonia these were

BAAL or BEL, the Father God, the Sun, hot, active, light, the positive principle, and ASTARTE, ASTAROTH, or ISHTAR (for whom the festival of Easter was originally celebrated), the Mother Goddess, the Moon, cold, passive, heavy, the material and negative principle. In Egypt the same were OSIRIS, the Sun, and ISIS, the Moon.

To the student of the history of chemistry, the Emerald Table of HERMES TRISMEGISTOS (2) is an especially interesting document. It is a sincere, sober, and succinct exposition of the ancient doctrine which was at once both cosmogony and metaphysics.

The words of the Secrets of Hermes which were written on the Table of Smaragd which was found between his hands in an obscure cave in which his buried body was discovered.

True without lie, certain and most true. That which is below is as that which is above, and that which is above is as that which is below, for accomplishing the miracles of a single thing. And as all things were from one, by the meditation of one, so all things were born from this one thing, by adaptation. The Father of it is the Sun, the Mother of it the Moon. The wind bore it in its belly. Its nurse is the earth. The father of all the telesmus of the whole world is here. Its force is unimpaired if it is turned into earth. You will separate the earth from the fire, the subtle from the dense, carefully and with great ingenuity. It ascends from the earth into the sky and again descends to the earth, and it receives the force of things above and of things below. So you will have the glory of the whole world, and so all obscurity will fly from you. Here is the strong fortitude of all fortitude, for it will conquer everything subtle and will penetrate everything solid. So the world was created. Hence there will be marvelous adaptations of which this is the mode. And so I am called Hermes Trismegistos, having three parts of the philosophy of the whole world. It is complete what I have said concerning the operation of the Sun (3).

The document is at least as old as the Christian era, and it

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(2) See *Jour. Chem. Education*, 3, 863-875 (1926), also JULIUS RUSKA, *Tabula Smaragdina*, (Heidelberg, 1926).

(3) This is a translation of the Latin version which was commonest among the European alchemists. Other Latin versions exist, and indicate that two slightly different versions of the Table probably existed before the Latin translations. These two must have derived from another still earlier version. For the present purpose, the exact language of the Table is not as important as its spirit and intent.

evidently summarizes a doctrine which is very much older than that. Moreover, it plainly contains no chemistry or alchemy. It is quoted in the present discussion because it supplies in brief form a standard with which the Chinese *Yin-Yang* doctrine may conveniently be compared, and because it serves to emphasize the fact that the dualistic doctrine existed in Egypt or in the Mediterranean basin, separate from chemical and alchemical relationships, as late as the beginning of the Christian era.

No dualistic doctrine of chemistry is known in Europe or in the Mediterranean basin before the time of ZOSIMOS, about the third century A.D. At some time later than this the chemists took over the Emerald Table, read chemistry into it, and adopted Hermes as their patron saint.

The Sun and Moon of the Emerald Table are not identical with the *Sol* and *Luna*, gold and silver, of the mediaeval Latins. They are, however, the same as the two principles, Sulfur and Mercury, of ZOSIMOS, GEBER, and the later alchemists and chemists. The identity appears to be fully established by a passage in the *Tractatus de metallis et Alchimia* (4)—

> We touch first on these points in a special discussion of the metals, what are the father and the mother of the metals? as the alchemists and Hermes Trismegistos say when they speak metaphorically. For sulfur is in effect the father and quicksilver in effect the mother.

Just as the Sun and Moon of the Emerald Table produce all things, so the Sulfur and Mercury principles give rise to minerals and metals. The chemical doctrine is set forth clearly in the *Speculum Alchemiae* which is ascribed to ROGER BACON (5).

> It ought to be noted that the mineral principles in mines are Quicksilver and Sulfur. The complex metals and all other mineral substances, of which the varieties are many and diverse, are procreated from these. I say that nature always sets before herself as an object the perfection

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(4) FRITZ PANETH, Ueber eine alchemistische Handschrift des 14. Jahrhunderts und ihr Verhältnis zu Albertus Magnus' Buch "De Mineralibus," *Arch. f. Geschichte d. Math., d. Naturwissenschaften u. d. Technik*, 12, 33 (1929). In the manuscript the passage reads, *Dicturi de metallis in speciali tangemus primo de hiis, quae sunt et pater et mater metallorum, ut dicunt metaphorice loquendo alchimistae et cimeginus Hermes. Sulphur enim est quasi pater et argentum vivum quasi mater.* But it seems reasonable to recognize *cimeginus* as a copyist's error for *Trismegistus*.

(5) See *Jour. Chem. Education*, 8, 1945-1953 (1931).

of gold and strives for it. But various supervening accidents transform the metals, as is set forth plainly in many books of the philosophers. For pure and impure metals are generated according to the purity or impurity of the prime two, that is, of the Quicksilver and of the Sulfur.

ALBERTUS MAGNUS, in the treatise *de Alchemia* (6), states that " fetid earth " and " corrupt sulfur " are the causes which prevent the formation of the perfect metal, gold, whenever the two principles enter into combination.

It is to be noted that the metals differ among themselves only in their accidental form, not in their essential, and that a spoliation of the accidents in metals is therefore possible. Hence it is possible by art to constitute a new substance, because all classes of metals are generated in the earth from Sulfur and Quicksilver combined, or are generated because of fetid earth. ... Just so it is among the metals which are corrupted either from corrupt sulfur or from fetid earth. Hence this is the difference of all the metals which differ among themselves. When clean red Sulfur encounters Quicksilver in the earth, thence gold is generated in a short or in a long time by the assiduity or decoction of nature subservient to it. When indeed clean and white Sulfur encounters Quicksilver in clean earth, thence silver is generated which differs from gold in this, that the Sulfur in gold was red and in silver it was white. When red, corrupt, and combustible Sulfur encounters Quicksilver in the earth, thence copper is generated which does not differ from gold except in this, that in gold the Sulfur was not corrupt. When indeed white, corrupt, and combustible Sulfur encounters Quicksilver in the earth, thence tin is generated, and it is such that it creaks between the teeth and has rapid liquefaction because the Quicksilver was not well commixed with the Sulfur. When indeed white, corrupt, and combustible Sulfur encounters Quicksilver in fetid earth, thence iron is generated. When black and corrupt Sulfur encounters Quicksilver, thence lead is generated, concerning which Aristotle says that lead is leprous gold.

In his effort to improve the current doctrines of chemistry, BECHER in the seventeenth century gave the name of *terra pinguis* (fat earth) to the fiery, positive principle. This was not a really important improvement, for the Arab writers, long before, had been accustomed to speak of the fatty and oleaginous nature of combustible materials. ALBERTUS MAGNUS and the Latin GEBER in language practically identical had said that " Sulphur is *pinguedo*

(6) *Theatrum Chemicum*, 2, 488-489, Ursellis, 1602.

terrae (fatness of the earth) thickened by temperate decoction in the mines of the earth until it is hardened and toughened; and when it is hardened it is called Sulfur " (7). STAHL's great contribution was the discovery, or more exactly the pointing out, of the fact that combustibility is transferable. As we would now say, the material which results from a reduction is itself capable of acting as a reducing agent. He gave the name of *phlogiston* to the ancient principle, using for the purpose a word which had appeared earlier in the chemical discussions of BOYLE, SENNERT, and EGLIN (8).

. The dualistic doctrine of Egypt and Mesopotamia, followed from early times to comparatively recent ones, thus shows us a cross-section of the history of European chemistry (9). In the present paper an examination is commenced of the relations of the dualistic doctrine to Chinese alchemy. The relations are all the more interesting because the doctrine appears to have been an importation into China while alchemy seems to have been of native Chinese growth and an exportation to the Arabs and to Christian Europe.

LIU AN (7270, 44) or HUAI-NAN-TZŬ (5034, 8128, 12317) (died 122 B.C.) is the first notable Taoist who is supposed to have written on alchemy. He was the grandson of HAN KAO-TI (3836, 5927, 10942), the founder of the *Han* dynasty, and was created Prince of *Huai-nan*. He was fond of books, and was

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(7) ALBERTUS MAGNUS in the *de Alchemia* (loc. cit., p. 496) says—*Sulphur vero pinguedo terrae est in minera terrae per temperatam decoctionem inspissata, quousque induretur, & fiat spissa : & cum indurata fuerit, vocatur sulphur.* GEBER (*Alchemiae Gebri Arabis*, etc., Berne, 1545, p. 47) has it—*Dicimus igitur quod Sulphur est pinguedo terrae*, etc., *sicca* instead of *spissa*, otherwise the same.

(8) ROBERT BOYLE in *The Sceptical Chymist* (1st. ed., London, 1661, p. 309; Everyman's ed., New York, n.d., p. 167) quoted a passage from DANIEL SENNERT which contained the word. RAPHAEL EGLIN (1559-1622) who wrote under the pseudonym of HAPELIUS, published a *Nova disquisitio de Helia Artista Theophrasteo : in qua de metallorum transformatione adversus Hagelii et Pererii Jesuitorum opiniones evidenter et solide disseritur*, Marburg, 1606, in which he says that " τὸ φλογιστόν is something proper to all Sulphur, the essence of that Sulfur which is ingrafted in all things." See *Annals of Medical History*, 6, 280-287 (1924); *Jour. Soc. Chem. Ind.*, 44, 725-727 (1925).

(9) For a fuller account, with a discussion of the elaboration of the doctrine into three and seven, of the seven metals, the seven planets, the seven days of the week, etc., see *Jour. Chem. Education*, 12, 3-10 (1935).

devoted to the study of alchemy and the search for the pill of immortality on which subjects he is said to have written several treatises. The Emperor WU-TI (12744, 10942) esteemed him highly and in the year 129 B.C. excused him from the ceremonies of vassalage. After this he seems to have involved himself in some treasonable conspiracy with a view to securing succession to the throne. WU-TI sent a Commissioner to punish him, but before the latter could arrive HUAI-NAN-TZŬ had died by his own hand. According to another story his son engaged in the conspiracy and was executed for it, and HUAI-NAN-TZŬ committed suicide because of the resulting humiliation. Tradition however asserts that he prepared the pill of immortality, that he took it, and ascended to heaven in broad daylight. (10)

WEI PO-YANG (12567, 9340, 12883) in the *Ts'an T'ung Ch'i* (11548, 12269, 1053) (written about 142 A.D.) makes reference to an earlier alchemical tradition and to the old masters of the art, and twice mentions HUAI-NAN-TZŬ (11). KO HUNG (6069, 5252) (281-361 A.D.) in his chapter on the Yellow and the White, the sixteenth of the Inner Chapters of *Pao-p'u-tzŭ* (8709, 9512, 12317), mentions a work of HUAI-NAN-TZŬ which is not now known to exist, the *Chên Chung Hung Pao* (630, 2875, 5269, 8720) (The Great Treasure in the Pillow-Chest) and tells a story from it about a successful transmutation (12).

The only writing of HUAI-NAN-TZŬ which has come down to us is a treatise on cosmogony entitled *Hung Lieh Chieh* (5269, 7086, 1515) (Explanation of the Great Light). It was originally called *Hung Lieh*, the word, *Chieh* (explanation), having been added to the title in the time of the *Sung* dynasty. It is a part of the Taoist Canon and is printed in Vol. 863-867 of the Collected Taoist Classics, Commercial Press Ltd., Shanghai, where it

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(10) The account of LIU AN which is included in the *Lieh Hsien Ch'üan chuan* (7081, 4449, 3176, 2703) (Complete Biographies of the Immortals) has been translated by LU-CH'IANG WU and published in *Isis*, 18, 228-230 (1932) in the Introduction to WU's translation of the *Ts'an T'ung Ch'i* of WEI PO-YANG.

(11) *Isis*, 18, 244, 257 (1932).

(12) KO HUNG on the Gold Medicine and on the Yellow and the White, the Fourth and Sixteenth Chapters of *Pao-p'u-tzŭ*, translated from the Chinese by LU-CH'IANG WU with an Introduction, etc., by TENNEY L. DAVIS, *Proc. Amer. Acad. Arts and Sciences*, 20, 221-285 (1935).

consists of 28 chapters and is accompanied by the commentary of Hsü Shên (4761, 9846) (13).

At the suggestion of the present writer Dr. Chia Wei Ou (1158, 12533, 30885) (14), now at Amoy University, has searched the text for references to the pill of immortality, alchemy, *Huang-Lao* (5124, 6783), *Wu-hsing*, etc. He has reported that the work contains no alchemy, and has supplied the translation (15), printed below, of certain passages relative to *Yin-Yang*, these being as near to alchemical doctrine as anything which is contained in the treatise.

It *(Tao)* extends to the four corners of the earth and embraces *Yin-Yang*.

Its virtues enrich heaven and earth, and rectify *Yin-Yang*, regulate the four seasons, and adjust (harmonize) *Wu-hsing*.

The supreme *Tao*... ascends and descends with *Yin-Yang*.

Therefore the great man (one who understands *Tao*) appears without worry or anxiety and lets heaven be his shelter, earth his vehicle, the four seasons his horses, and *Yin-Yang* his charioteer. To let *Yin-Yang* be his charioteer leaves nothing wanting.

If one transplants a tree without keeping its *Yin-Yang* nature, he will certainly find that it withers and decays...

Extreme anger causes *Yin* to break; excessive joy causes *Yang* to descend (16).

Those who have acquired the proper principles will not regard luxury as happiness or poverty as sorrow, and will close with *Yin* and open with *Yang*...

Before the universe took any definite form it was absolutely shapeless and transparent, and was therefore called *T'ai Chao* (10573, 473) (Great Brightness). *Tao* originated itself from emptiness and tranquillity. Emptiness and tranquillity created *Yü Chiu* (13540, 2465) (space and

(13) Hsü Shên lived in the later *Han* dynasty (24-194 A.D.). He was well versed in the classics, especially the " Five Classics " in which it was said that none of his contemporaries could surpass him. He made a thorough study of Chinese etymology, and investigated and classified the six methods by which all Chinese words are supposed to have been made. He wrote *Shuo Wen Chieh Tsu* (10164, 12633, 1515, 12324) (Treatise on the Derivation of Words and Phrases) in 14 chapters which has remained an authoritative text on Chinese etymology.

(14) Ou is the family name.

(15) For financial aid in defraying the expenses of the preparation of the translation, I wish to make grateful acknowledgement of a grant from the Permanent Science Fund of the American Academy of Arts and Sciences. T. L. D.

(16) *Yang*, the positive masculine principle, was supposed normally to ascend.

time) (17), and space and time created *Ch'i* (1064) (air or ethereal essence). *Ch'i* had boundaries. The portion which was thin and volatile floated up to form the sky, and the heavy and dense portion condensed and coagulated to become the earth. Since it is easier for volatile things to come together than for heavy and dense materials to condense and coagulate, the sky formed before the earth took definite shape. *Yin-Yang* resulted from the concentration of the essence *(Ching)* (2133) of heaven and earth. The essence of *Yin-Yang* by its concentration formed the four seasons, and the essence of the four seasons by its distribution formed the multitude of things. The accumulation of the hot elements in *Yang* originated fire, the essence of which became the sun. The accumulation of the cold elements in *Yin* created water, the essence of which became the moon. By the interaction of the sun and the moon the heavenly bodies were produced (18). While the heaven received the stars and planets, the earth received water and dust.

When KUNG KUNG (6571, 6553) and CHUAN HSÜ (2714, 4720) (19)

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(17) These two terms, taken together, mean the universe in present Chinese. The commentator explains that the first term means the four directions and the vertical, that is, the three dimensions or space, and the second term means past, present, and future, that is, time.

(18) Five heavenly bodies besides the Sun and the Moon—associated in Chinese thought with the *Wu-hsing*, as follows: Jupiter with Wood, Mars with Fire, Saturn with Earth, Venus with Metal, and Mercury with Water—making seven heavenly bodies altogether. See HERBERT A. GILES, *A Chinese-English Dictionary*, 2nd. ed., London, 1912, Part I, pp. 28-29, also *Isis*, 18, 220 (1932); 22, 270 (1934).

The Chinese idea that the prime two produced five others is similar to the Egyptian opinion, as is evident from a passage in the writings of the historian, DIODOROS of Sicily (about 90 or 80 to 30 B.C.) which passage also describes briefly the characters of the prime two and mentions, as HUAI-NAN-TZŬ does, that they both have "something of the air."

"They say that these gods (Osiris and Isis) in their natures do contribute much to the generation of all things, the one being of hot and active nature, the other moist and cold, but both having something of the air, and that by these all things are brought forth, and nourished, and therefore that every particular being in the universe is perfected and completed by the Sun and Moon whose qualities as before are five; a spirit of quickening efficacy, heat or fire, dryness or earth, moisture or water, and air, of which the world does consist as a man is made up of head, hands, feet, and other parts. These five they reputed for gods; and the people of Egypt, who were the first that spoke articulately, gave them names proper to their several natures according to the language they then spoke. DIODORUS SICULUS, *Historical Library*, Book I, Chapter I, *trans.* BOOTH. Passage quoted by STILLMAN, *The Story of Early Chemistry*, p. 130, New York and London, 1924.

(19) The former was an official of the judiciary under the legendary Yellow Emperor, HUANG-TI; the latter was this Emperor's grandson. The mountain, *Pu Chou*, was said to be situated in the northwest.

were fighting for the throne, they angrily hit against the *Pu Chou* (9456, 2450) mountain. As a result of this struggle, the columns which supported the sky there and the fastenings which held the earth in place were broken. Thus the sky became inclined toward the northwest and the positions of the heavenly bodies were altered. Space in the southeast was no longer occupied by the earth, and the water and dust ran toward it.

The *Tao* of heaven is round while the *Tao* of earth is square. The nature of square things is dark and the nature of round things is bright. Things that are bright emit *Ch'i* (vapor or essence); therefore light shines outwardly from fire. Things that are dark absorb *Ch'i;* therefore images form inwardly in water. The function of things that emit *Ch'i* is to give and that of things that absorb *Ch'i* is to transform. Therefore *Yang* gives and *Yin* transforms.

Wind is caused by the angry and unbalanced *Ch'i* of the sky; rain is formed from the harmonized *Ch'i* of heaven and earth. When *Yin* and *Yang* approach one another, they react to produce thunder, strike each other to form rapid thunderbolts, and diffuse at random to form fog. When the *Yang Ch'i* predominates, they spread out to form rain or dew. When the *Yin Ch'i* predominates, they congeal to produce snow or frost.

Those creatures which possess hairs and feathers fall into the flying and running group and therefore belong to *Yang;* while those wearing scales and shells fall into the hiding and hibernating group and therefore belong to *Yin.* Since the sun is the master of *Yang*, the covering of animals is reduced when spring and summer come, and the elaphure and the ordinary deer discard their antlers at the winter and at the summer solstice respectively. Since the moon is the origin of *Yin*, the brains of fishes grow smaller as the moon diminishes, and the flesh of clams and muscles does not grow when the moon is dead. Because fire ascends and water descends, birds fly upward and fish move downward.

Similar things behave similarly. Ends echo beginnings. If a golden cup be placed on dry grass under a hot sun, fire is produced. If a large oyster be exposed to moonlight, drops of water are formed. The roaring of a tiger causes wind to blow in the valley, and if the dragon raises his head colored clouds are formed. Fights between unicorns cause eclipses of the sun and moon. When a whale dies, a comet appears. Silk worms playing with silk cause the *Shang* (9738) (20) string to

(20) The *Shang* note is the second of the five ancient Chinese musical notes. Each of the eight kinds of musical instruments, whether made of silk, of bamboo, of metal, of stone, of wood, of earth, of leather, or of calabash, was capable of producing the five notes.

break, and the falling of meteors causes the Pechili Sea to overflow.

The aspect of the heavens is related to the conduct of rulers. The assassination of cruel rulers is usually accompanied by strong winds, violations of edicts and laws by the damaging of crops by insects, the execution of innocent persons by drought, and disobedience of orders by excessive rainfall.

The four seasons are the ambassadors of heaven, the sun and the moon are the angels, the stars and the planets are the periods, and male (21) and female rainbows and comets are the ill omens.

The foregoing translation no doubt contains matter which does not relate very closely to the argument of the present paper, but the scarcity of source material in a European language on early Chinese science probably makes it desirable to publish all of the translation which we have been able to procure. At the same time it may possibly be the case that the *Hung Lieh Chieh* contains alchemical material which has escaped the notice of the translator (22). At any rate the translation serves our present purpose to the extent that it shows the general similarity between the dualistic doctrine of HUAI-NAN-TZŬ and that which is summarized in the *Emerald Table* and prevailed in Egypt and Mesopotamia at an early date.

The doctrine of the Two Contraries constituted a general scientific background first for physical and cosmological, metaphysical and religious theories, at a later time for theories of chemistry, medicine, psychology, and the more specialized sciences. It is well known that ZOSIMOS, about the third century A.D., erected a chemical theory upon it, teaching that metals and mineral substances are compounded from the two opposite principles. That chemical theory however is a far cry from the alchemy of the Arabs and mediaeval Latins, from the opinion that the contrary principles may each be isolated in a state of purity and then combined with one another in the proper proportion to produce the perfect metal, or that a material possessing a deficiency of one or the other principle may be

(21) Male rainbows are those which show a variety of brilliant colors.

(22) OBED S. JOHNSON, *A Study of Chinese Alchemy* (Shanghai, 1928, p. 75, *fn.*), states that LIU AN taught that "gold grows in the earth by a slow process, and is evolved from the immaterial principle underlying the universe, passing from one form to another up to silver and then from silver to gold."

combined with one that contains a superfluity of it for the same effect. The logical relations between the dualistic chemical theory and the practice of alchemy are such that the theory can exist without the practice, but the practice not for a thoughtful mind without the theory. The speculative Alexandrians did indeed apply their theory to the interpretation of the chemical phenomena about which they had learned from old Egypt, but the practical art of changing the substance of the metals does not seem to have attracted the interest of Europeans before the eighth century or thereabouts. The practical Chinese on the other hand wished for transmutation. They wanted gold and silver in order that they might attain immortality by eating the noble metals (23). They proceeded at once to alchemy. If we may judge from the limited evidence which is now available, their speculations supplied an explanation of the transmutatory process and determined its procedure rather than furnished a general account of a diversity of chemical phenomena.

The *Ts'an T'ung Ch'i* of WEI PO-YANG is the earliest known treatise in any language which is devoted exclusively to the subject of alchemy. Its author says of it, correctly, that it "is only an outline of principles written in a rather involved style and interspersed with extraneous material." It seems disjointed and lacking in continuity, and contains many passages which mean but little except by comparison with other passages in other parts of the treatise. But it is an intricately woven brocade the details of which acquire significance by a consideration of the general pattern. Thus, it takes the *Yin-Yang* doctrine as a matter of course and is sprinkled with references to it, which references, taken altogether, make up a fairly complete account of that aspect of it which is important to the student of alchemy. Several of the passages remind one strongly of portions of the *Emerald Table*. Disconnected portions here and there seem to suggest a dualistic theory of the composition of the metals, but perhaps really relate to a dualistic theory of gold-making. Other passages, clearly related, describe the alchemical process by which the pill of immortality (gold) is produced by the combination of *Yin* and *Yang*. The process, the apparatus, and the manipu-

(23) See KO HUNG on the Gold Medicine, etc., *loc. cit.*

lation are the same as those which are later described by the alchemists of the Middle Ages.

WEI PO-YANG says that the sun is *Yang* and the moon is *Yin* (24) and that Dragons are *Yang* and Tigers are *Yin* (25), supplying us with synonyms and a clue to the better understanding of his language. " To have provided the positions is to have placed *Yin* and *Yang* in matching positions... (26). The sun and the moon reach out for and hold one another. Masculine *Yang* scatters the black spread abroad and feminine *Yin* is in charge of the yellow transformation... (27). *Yin* and *Yang* drink and devour one another... (28). *Yang* donates and *Yin* receives "... (29)

The primordial substance, shining forth unseen, will illuminate the insides of the body. All the openings must be blocked up so as firmly to protect the divine plant... (30) The yellow center gradually develops. Moistness and fluidity reach the surface... (31). On the sides there is the walled inclosure, shaped like a *P'éng-hu* pot. Closed on all sides, its interior is made up of intercommunicating labyrinths. The protection is so complete as to turn back all that is devilish and undesirable, and the meandering passages take good care of emergencies... (32). Like the moon lying on its back is the shape of the furnace and the pot. In it is heated the White Tiger. Mercury Sun is the flowing pearl and with it is Blue Dragon. The east and the west merge together... (33). Treatment and mixing will bring about combination and rapid entrance to the scarlet portal. The escape must be firmly blocked. Below plays the dazzling flame, while the Dragon and Tiger keep up a sustained vociferation. The flame at the start should be weak, so as to be controllable, and should be made strong at the end. Close attention and careful watch should be given so as to regulate properly the heat and cold... (34). The Dragon breathes into the Tiger and the Tiger receives the spirit from the Dragon. They mutually inspire and benefit.

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(24) *Isis*, 18, 250 (1932).
(25) *Ibid.*, p. 255.
(26) *Ibid.*, p. 232.
(27) *Ibid.*, p. 233.
(28) *Ibid.*, p. 244.
(29) *Ibid.*, p. 245.
(30) *Ibid.*, p. 236.
(31) *Ibid.*, p. 237.
(32) *Ibid.*, p. 238.
(33) *Ibid.*, p. 239.
(34) *Ibid.*, pp. 243-244.

They eat and devour one another... (35). Above, cooking and distillation take place in the caldron; below blazes the roaring flame. Afore goes the White Tiger leading the way; following comes the Grey Dragon. The fluttering Scarlet Bird flies the five colors. Encountering ensnaring nets, it is helplessly and immovably pressed down... Before half the time has passed, Dragons appear with rapidity and in great number. The five dazzling colors change incessantly. Turbulently boils the fluid in the *Ting*. When *Yin* and *Yang* are properly matched, tranquillity prevails (36).

WEI PO-YANG's process is plainly the same as that, so often discussed in the Latin works on alchemy, in which the positive principle or "Sulfur of the Philosophers" is heated with the negative "Mercury of the Philosophers" or Azoth in a vessel which is hermetically sealed to prevent the escape of volatile matter. In European practice the vessel was sometimes enclosed within another sealed container to form what was known as the "Philosophers' Egg." Heated, as WEI PO-YANG and the *Speculum Alchemiae* of ROGER BACON both describe it, at first slowly and finally with a strong fire, it yielded the pill of immortality or the Philosophers' Stone.

While we do not find in the writings of WEI PO-YANG any clear-cut dualistic doctrine of chemistry, we do find an account of the alchemical process based directly upon *Yin-Yang*. The ancient doctrine of the Two Contraries was evidently imported into China where a mystical idea-system gave practical people strong motives for seeking an immortality which was not promised by their religion. Here it seems to have furnished a general scientific background upon which alchemy sprang up, an alchemy identical in theory and practice with the later alchemy of mediaeval Europe. The facts confirm the opinion that alchemy came to Europe from China, probably through the agency of the Arabs in the eighth or ninth century, and that it there mingled with the purely chemical tradition of Alexandria to make up the body of information and practice, knowledge and speculation, which was the alchemy and chemistry of mediaeval Europe.

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(35) *Ibid.*, pp. 252-253.
(36) *Ibid.*, pp. 258-259.

Duhem and Jordanus Nemorarius

In the preface to his *Origines de la Statique*, PIERRE DUHEM wrote :

" L'étude des origines de la Statique nous a conduit ainsi à une conclusion; au fur et à mesure que nous avons poussé nos recherches historiques plus avant et en des directions plus variées, cette conclusion s'est imposée à notre esprit avec une force croissante; aussi oserons-nous la fomuler dans sa pleine généralité : La science mécanique et physique dont s'enorgueillissent à bon droit les temps modernes déroule, par une suite ininterrompue de perfectionnements à peine sensibles, des doctrines professées au sein des écoles du moyen âge; les prétendues révolutions intellectuelles n'ont été, le plus souvent, que des évolutions lentes et longuement préparées; les soi-disant renaissances que des réactions fréquemment injustes et stériles; le respect de la tradition est une condition essentielle du progrès scientifique."

This far-reaching statement points in two directions : if the evidence adduced by DUHEM really stands up, then indeed we must revise our customary ideas on the history and development of modern science; on the other hand, if the evidence proves forced or unsubstantiated in any respect, then the very sweeping nature of DUHEM's conclusion must be regarded as the expression of a deep-seated apologetic bias, and consequently all his findings must be scrutinized with the same suspicion as a lawyer's brief for a client.

It is easy to show that much of the evidence which DUHEM adduces in support of his thesis is palpably far-fetched. Thus to go no further than the field of statics (and to omit DUHEM's views on the connection between the mediaeval impetus theory and the principle of inertia, which would take us too long to discuss here), what shall any scientifically-informed person say of DUHEM's attempt to link, " par une filiation qui n'a point subi d'interruption," the principle of TORRICELLI with ALBERT OF SAXONY's speculations on the Aristotelian theme of natural places? When it is borne in mind that TORRICELLI's principle—that a system of bodies is in equilibrium when the common center of gravity

cannot sink—does not represent the discovery of any new primary fact but only of a more powerful way of expressing the previously discovered facts of statics (notably the work of GALILEO and STEVINUS), and when it is also borne in mind that the work of ALBERT, while concerned with philosophical physics, in no wise contributed or was intended to contribute to the mathematical tradition of statics, one can begin to understand how completely forced is the effort to associate ALBERT OF SAXONY with the scientific development of modern statics. Only on the theory that the use of a certain concept—and not even the first use, for the term center of gravity has a long mathematical history before its use in ALBERT's speculations—establishes a patent on any future scientific discoveries that may utilize the word, can any one maintain a connection between ALBERT and TORRICELLI. And if this view seems unnecessarily harsh to DUHEM's effort, I would ask any one who doubts it to read through the second volume of the *Origines* (the greater part of which is devoted to establishing the connection between ALBERT and TORRICELLI) and see if he can come out with any clear idea concerning something essential which ALBERT is supposed to have contributed to the development of statics.

While on account of the abstruse nature of DUHEM's own theories, few historians have taken seriously the contention as to the connection between ALBERT and modern statics, DUHEM's contentions concerning JORDANUS NEMORARIUS have been accepted on a different footing. Precisely because the work of JORDANUS and of his supposed school concerns mathematical statics and because DUHEM has cited several significant true propositions, historians, with one or two exceptions, have tended to accept all of the French scholars statements on the subject without independent check; and they have thus spread the belief that in this instance at least the thesis of the mediaeval origin of modern science has been demonstrated.

It is the object of the present paper to test DUHEM's assertions on the JORDANUS problem by reference to the texts of the original manuscripts.

I.

At the outset it should be stated that the various manuscripts on weights or statics attributed to JORDANUS belong to a group of mediaeval Latin manuscripts on statics, several of which are ascribed falsely to EUCLID and ARCHIMEDES. By internal evidence (such as, for example, the order of the letters in the geometrical figures) most of these manuscripts are traced to Alexandrian sources with Arabic intermediaries. VAILATI (*Scritti*, p. 92-3) was inclined to regard the JORDANUS manuscripts as also of Greco-Arabic origin, but inasmuch as in the case of many of the propositions there are no parallels in any of the classical works, it is only fair to attribute a mediaeval authorship, even though some parts obviously date back to Alexandrian sources.

DUHEM, not content with giving a mediaeval authorship to the JORDANUS tracts on weights, ascribes the tracts to two or three mediaeval authors, of whom JORDANUS NEMORARIUS the mathematician would be only one. The basis for the multiple authorship is that these tracts on weights, bearing the title *De Ponderibus* or some variant, have come down to us in three main versions. There is first of all a thirteen-proposition version, such as was printed in 1533 by APIAN in combination with an introduction and an extra set of demonstrations which are attributed by DUHEM to the labors of some peripatetic commentator on the original JORDANUS manuscript. There are a number of manuscripts of the thirteen-proposition version, some of them carrying the title *Euclides de Ponderibus* (the confusion of name probably arising from the similarity of JORDANUS' opening propositions with those of a fragment circulating in the Middle Ages as a work of EUCLID *De Levi et Ponderoso*). The second main version is a 45-proposition version, such as furnished the text for the very garbled printed edition of *Jordani Opusculum de Ponderositate* (1565). This version is usually divided into four books. The third main version comprises the thirteen-proposition version and the last three books of the preceding version (1).

(1) I have had at my disposal, through the courtesy of Columbia University Library, photostatic copies of two manuscripts of the 45-proposition version (Fonds Latin 8680 A of the Bibliothèque Nationale of Paris and Regino Latino

DUHEM maintains that the thirteen-proposition version was originally one of nine propositions, and that these nine propositions are all that can be attributed to JORDANUS himself. There are indeed manuscripts containing the nine propositions alone, and the other four propositions are also found independently as a fragment with the name *De Canonio*, which DUHEM believes to be of Greek origin. As regards the 45-proposition tract, DUHEM originally regarded it as the work of some disciple of JORDANUS, who utilized most of JORDANUS' propositions and also others from Greek sources, while at the same time adding original and important propositions of his own (notably the propositions in the first book dealing with the equilibrium of equal weights on a bent lever of unequal arms and with equilibrium on an inclined plane, as well as several propositions in the third book which DUHEM regarded as foreshadowing the concept of statical moment). On the discovery of the third type of manuscript—that is to say, the type that contains the last three books of the 45-proposition version joined to the thirteen-proposition version in place of the usual first book—DUHEM came to the conclusion that the 45-proposition version is the work of two persons—a disciple of JORDANUS, who wrote the first book, and a follower of Greek traditions, who wrote the last three books as an independent treatise.

What added an element of comedy to DUHEM's change of views was that in addition to originally labelling the author of the 45-proposition version as a disciple of JORDANUS, he had also given him the title "Precursor of LEONARDO," in the belief that it was through him that the seed of JORDANUS was developed, and the finished fruit passed on to modern science via the notebooks of the great Florentine painter-scientist. Unfortunately though there are allusions in LEONARDO's notebooks to *Jordanus de Ponderibus*, DUHEM searched in vain for any trace of influence

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1261 of the Vatican Library) as well as a photostatic copy of a manuscript of the 13-proposition version (Vat. Latino 2975 of the Vatican Library). The printed *Jordani Opusculum de Ponderositate* is also available at the Columbia University Library, while the APIAN edition is available at the New York Public Library. The research on this paper has been made possible by a grant from the Columbia University Council of Research on the Humanities, to whom I desire to express my gratitude and appreciation. To Professor FREDERICK BARRY especially I desire to express my gratitude for his counsel and guidance.

of the precursor's demonstration of the inclined plane on LEONARDO's fumbling attempts to work out the same proposition. DUHEM therefore came to the conclusion that LEONARDO must have had before him a manuscript of the third type, without the inclined plane demonstration. Nobody knows of course what manuscript LEONARDO consulted, and even if he had had the manuscript with the inclined plane proposition he might have rejected that demonstration as did most of the thinkers of the sixteenth century. But regardless of whatever manuscript LEONARDO read or did not read, the title "Precursor of LEONARDO" became obviously unsuited to the author of the first book, whose chief glory was the enunciation of the proposition of the inclined plane. Let DUHEM state his difficulties in his own words :

"A l'auteur inconnu des quatre livres *De Ponderibus*, nous avions proposé de donner un nom; nous l'avions appelé le Précurseur de LÉONARD DE VINCI. Or, voici que cet auteur se dédouble, pour ainsi dire, et que nous trouvons en lui deux personnages : un géomètre adepte de la Science hellène a redigé les trois derniers livres de l'ouvrage; un mécanicien occidental, disciple de JORDANUS DE NEMORE, a composé le premier. Au premier de ces deux auteurs le titre de Précurseur de LÉONARD convient très exactement... Au contraire les théorèmes du second sont demeurés inconnus à LEONARD; celui-ci a ignoré la belle solution donnée par celui-là au problème du plan incliné... L'auteur de cette découverte ne mériterait-il pas le titre de Précurseur de SIMON STEVIN? ou bien encore le titre de Précurseur de DESCARTES?" (*Études sur Léonard de Vinci*, vol. I, p. 316).

VAILATI, after DUHEM's work was published, objected to the whole idea of attributing the JORDANUS manuscripts to multiple mediaeval authorship (see *Scritti*, p. 839). Nevertheless for twenty-five years DUHEM's conclusions passed current among historians (usually in the earlier form, without the correction which DUHEM made in the *Études sur* LÉONARD DE VINCI), until at length in 1930 Professor R. MARCOLONGO of Naples, in the course of his monograph on the Mechanics of LEONARDO DA VINCI (*Atti, R. Accad. d. scienze matem. e fisiche*, vol. 19) decided to wield OCCAM's razor on this historical problem. Keeping in mind the mathematical reputation of JORDANUS NEMORARIUS (as evidenced by his geometrical and algebraic treatises), MARCOLONGO came to the conclusion that one author—namely JORDANUS—was quite sufficient to account for all the treatises *De Ponderibus* labeled with his name, and that the various classes of manuscripts represent briefer or longer versions of the same work.

This conclusion I have been able to confirm by a comparison of the thirteen-proposition and forty-five proposition manuscript texts. The first nine propositions of the thirteen-proposition version, which DUHEM attributes to the historical JORDANUS NEMORARIUS, are prefaced by certain axioms or postulates concerning weight relative to position *(gravitas secundum situm)*, and the propositions are intended to work out these axioms in various lever problems. The essential axiom is that a weight is heavier by virtue of its position (in the sense of being able to balance a larger weight) when its motion—presumably in the event of a rupture of equilibrium—is more nearly in a vertical direction. As may readily be understood, this axiom contains the germ of an idea which might lead to the enunciation of the law of the inclined plane. The axiom is not stated, however, with mathematical precision, and is tied up to the Aristotelian idea of measuring the power of a weight by the downward velocity (the larger the weight, the larger the velocity of fall) and, what is worse, by the resistance to upward motion—the heavier the weight, the slower it is thrown upward. The last involves mathematical and logical contradictions quite apart from the empirical untenability of the fundamental proposition about downward speed being proportional to weight. In addition to the confused manner of enunciating the notion of *gravitas secundum situm*, we find its application to lever problems leading to egregious errors because of the absence of infinitesimal considerations in dealing with the rupture of equilibrium. As a result, there is nothing in the whole nine propositions that can be regarded as a scientific contribution, except possibly the demonstration of the general law of the lever (weights balancing when the arms are inversely proportional). In this demonstration no use is made of the notion or relative weight, but there is a phrase in which DUHEM claims to detect the germ of the modern principle of work—to wit, that if a force can raise a certain weight a certain height, it will raise a lesser weight to a proportionately larger height. We shall return to this later; for the moment it is sufficient to say that for DUHEM the contributions of JORDANUS are 1) the notion of relative or accidental weight or *gravitas secundum situm*, and 2) the enunciation of the germ of the principle of virtual work.

Now the contents of JORDANUS' work—his axioms and all but

two of his propositions—are taken over unchanged in the first book of the work of the so-called disciple. The two missing propositions deal with a lever, one arm of which is fixed and one arm movable. On the other hand, the propositions included by the so-called disciple which are not found in the work DUHEM attributes to JORDANUS, comprise one on the bent lever as well as the inclined plane demonstration. DUHEM claims that any one who could have enunciated a correct demonstration on the bent lever could not have been the author of the incorrect propositions on the half-movable and half-fixed lever, which directly contradict the correct proposition. He also claims a similar incompatibility with certain propositions in the third book (of the 45-proposition version) dealing with a balance in so far as it becomes a bent lever (that is to say a balance with the point of suspension above or below the line of the lever arms). Though in his corrected interpretation of the authorship of the last three books DUHEM makes these propositions the work of an independent writer, "a follower of Greek science," yet he links them to the disciple of JORDANUS by stating that the disciple wrote the first book to provide an introduction and a logical basis for the propositions of this writer, just as, in DUHEM's opinion, JORDANUS wrote his nine propositions to serve as an introduction to the four-proposition fragment of the *De Canonio*. The fact that in one set of manuscripts we have the thirteen-proposition version substituted in place of the first book of the disciple as an introduction to the work of the follower of Greek science is attributed by DUHEM to the carelessness of a mediaeval transcriber. To finish with the textual description, it may be said that DUHEM admits that the second book of the 45-proposition version (or the first book of the work of the follower of Greek science) deals with the same subject matter as the four propositions of the *De Canonio* (or the last four propositions in the thirteen-proposition version)—that is to say with lever problems in which the weight of the lever has to be taken into account. On the other hand, the last book in the forty-five proposition version deals with dynamics, so that regardless of its ultimate authorship there is no incompatibility in its being incorporated either with the propositions of JORDANUS or with those of his supposed disciple.

The multiple authorship of the JORDANUS manuscripts, as

maintained by DUHEM, turns, then, on the supposed incompatibility of the incorrect propositions on the lever with a movable arm with the correct proposition on the equilibrium of a bent lever. There is indeed a contradiction to modern eyes, but the fact is that throughout these manuscripts we find error strangely mixed with truth, the chief reason being that where the notion of relative weight did not suggest a proper geometrical analysis, there the author or authors fell into absurdities. On the other hand, as regards the proposition on the inclined plane, it may be said the notion of relative weight depending on the obliquity of motion seems to have been invented precisely to demonstrate that proposition (and was in all likelihood the empirical source of the axiom), so that it is not surprising to see the author arriving at truth there while arriving at error elsewhere by using the same axiom. Similarly, as regards the bent lever, the geometrical analysis revealed that in any motion the weight at the end of one arm would be raised higher than the weight on the other arm would be lowered, and as this was impossible the author concluded to the law of equilibrium when the weights are equal and when the distances from the vertical are equal. In the false propositions the mode of analysis is different, and the author involves himself in motions along circular arcs without keeping in mind the different relations to the vertical at different points. In the course of these propositions he implies that a weight at the end of a movable arm would be lighter in its effect than an equal weight at the end of a fixed horizontal lever arm even when the distance of the movable arm from the vertical would be just equal to that of the horizontal arm. The falsity of this proposition could be readily understood by any one who grasped thoroughly the principle of moment, but whether its falsity could be recognized by any one who merely was able to demonstrate correctly the law of the bent lever where both arms move with the same rotation is quite another question. The text which DUHEM attributes to the disciple contains (as does also the other text) the incorrect proposition that a lever with equal weights suspended at equal distances will return to level position when it is disturbed. It might be argued that the knowledge of the proposition of the bent lever, which shows that what counts is the horizontal distance, should have revealed the falsity of the proposition on the stability

of the lever, but nonetheless we find these two propositions existing side by side. A still greater contradiction is evident if we assume with DUHEM that the disciple composed his treatise as an introduction to an already existing treatise by a follower of Greek science, for in this work we find explicit formulations that in a bent lever if one side weighs more than the other, the heavier side will never reach the center of motion; also that when the pivot or fulcrum is below the lever the equilibrium is always unstable. These propositions are almost directly contradictory to the proposition which asserts stable equilibrium at level position of the ordinary level, and yet DUHEM finds it possible to believe that the disciple, who so thoroughly understood these propositions that he wrote his book to provide a logical basis of prerequisite propositions, could take over JORDANUS' false proposition about stable equilibrium without correcting it.

It is true that DUHEM (*Origines*, vol. I, p. 140) claims that the disciple did correct the demonstration in the sense of making additions " qui en sont une réfutation concluante." But a glance at the text shows that the correction exists only in DUHEM's mind. In the so-called JORDANUS version the proposition confines itself to demonstrating that the lever with equal arms and equal weights will return to level position even when it is put in an oblique position such that the arm *ac* is in the first quadrant of a circle and the arm *ab* is in the third quadrant (see figure 1). The

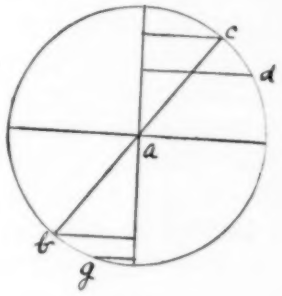

Fig. 1.

proof given is that if we take equal downward arcs *cd* and *bg*, the arc *cd* is supposed to be more " direct " or less oblique than the arc *bg*. Hence the weight *c* will be heavier in that position than the weight *b* and will bring the lever back to level position.

Inasmuch as by putting the lever in an oblique position the right arm becomes situationally heavier, the question then comes up as to what will happen when the left-hand weight *b* is physically heavier. Will the lesser weight *c*, with the advantage of its position, be able to lift the heavier weight *b* to the level position? This would of course contradict the known fact that the side of a lever with the heavier weight sinks and stays down. To meet this problem the manuscript of the so-called disciple adds a clause to the effect that if the weights are truly unequal, the heavier weight will always sink, and by a specious reasoning maintains that the gain in weight by virtue of position has no effect against an absolute discrepancy in weight. In short, he makes the rule of relative weight operate when he wants it to operate and not operate when he does not want it to operate.

It is this stultifying addition which DUHEM regards as a "correction à une erreur de JORDANUS." To quote again from DUHEM, "L'excès de l'obliquité de l'arc *bg* sur l'obliquité de l'arc *cd*, dit en effet notre auteur, peut être rendu plus petit que n'importe quelle quantité; de telle sorte que si l'on place en *c* un certain poids et en *b* un poids qui surpasse le poids *c* de n'importe quelle quantité fixe, le poids *b* descendra et fera monter le poids *c*." As regards the phrase "plus petit que n'importe quelle quantité," it should be said that the disciple manuscript uses the locution "*ut libet parvi*," whereas the so-called original Jordanus manuscript talks of taking arcs "*a quo libet puncto*." But no importance can be attached to this infinitesimal locution, which according to DUHEM's own statement (*op. cit.*, p. 119). is found in the JORDANUS manuscript in another proposition. Regardless whether the manuscripts talk of taking infinitesimally small arcs or whether they talk of taking any arcs of finite size, the underlying reasoning is in terms of finite arcs and in most cases leads to error; in this case even to give the author credit for infinitesimal considerations will not help much, as there is no way of explaining why relative weight should give an advantage when the two weights are physically equal and no advantage when the two weights are physically unequal.

The upshot of this analysis is that DUHEM's attempt to show a scientific progress from JORDANUS to his supposed disciple breaks down. There are of course variations in the manuscripts,

but we have no means of knowing which manuscript is the primitive one and which the later one. Scientifically they are all on the same level, although as it happens the 45-proposition version contains the few original and significant propositions which are to be attributed to the author or authors of these manuscripts, whereas the thirteen-proposition version contains almost nothing that is worth-while. Since the various manuscripts are all on the same intellectual level and differ merely in the selection of propositions, it is only fitting to follow the ascribed authorship and credit all the manuscripts to the same source, namely, the historical JORDANUS NEMORARIUS.

This view, of course, tends to minimize the strength of the creative movement in mediaeval mathematical statics, while DUHEM, in breaking up the JORDANUS treatises into the work of three authors (apart from the peripatetic commentator), has sought to magnify it. But inasmuch as DUHEM himself constantly has recourse to the idea of errors introduced by unintelligent copyists—errors of substance and not merely errors of individual words—the idea of a sustained movement of expert mechanicians is scarcely reasonable. There is no difficulty in revealing a long line of highly acute thinkers on the problems the mediaevals were really interested in; but on the mathematical and positive-scientific side, we find always the same phenomenon of isolated figures who leave no successors. Thus in the field of algebra we meet with LEONARDO OF PISA, who is a practical Italian utilizing Arabic sources and is outside the scholastic university tradition, and we find also, greatly inferior to his work, the algebraic writings of JORDANUS NEMORARIUS. But we do not find any algebraic successors to JORDANUS, and we have to wait until the period of the Renaissance for a revival of algebra, a revival which quickly surpassed the work of the Arabs. A similar story might be told as regards mathematical astronomy, where again we find isolated figures of one sort or another, with the intellectual climate too unfavorable to allow the creation of schools of successors. If the reverse situation were discovered to be true in a particular scientific field, we should indeed have to change our views about the intellectual climate of the Middle Ages—but the reverse has to be discovered as true : it cannot be hypothetically invented in order to change our views as to the mediaeval intellectual climate.

II.

So much for the historical problem of the authorship of the JORDANUS manuscripts. We turn to the question of the influence of the manuscripts on the development of modern statics. For this purpose it makes no difference what views we take on the authorship of the manuscripts, since we are dealing with the specific influence of the propositions and concepts.

For DUHEM, who limits JORDANUS' work to the first nine propositions of the thirteen-proposition version, the historical achievement of JORDANUS is limited, as we have already said, to the enunciation of the idea of *gravitas secundum situm* and to the alleged discovery of the germ of the principle of virtual work.

Let DUHEM speak on this point in his own words :

> " Parmi les démonstrations de JORDANUS," he writes, " il en est une qui mérite une attention toute particulière; elle ne fait point appel à la notion de la gravité *secundum situm;* le principe dont elle se réclame n'est point explicitement énoncé; mais, d'autre part, ce principe transparaît si clairement qu'il est impossible de ne point formuler ainsi: *Ce qui peut élever un certain poids à une certaine hauteur peut aussi élever un poids* k *fois plus grand à une hauteur* k *fois plus petite.* Ce principe est donc celui que DESCARTES prendra pour fondement de toute la statique et qui, grâce à JEAN BERNOULLI, deviendra le principe des déplacements virtuels. Il y a plus; nous verrons que le courant d'idées qui a apporté ce principe à DESCARTES et qui a pris sa source aux *Elementa* de JORDANUS n'a subi, dans son progrès, aucune discontinuité. C'est bien aux commentateurs de JORDANUS que DESCARTES a emprunté ce postulat." (*Origines*, vol .I, pp. 121-2).

When we turn to the text of JORDANUS' demonstration and contemplate it coldly in its context without DUHEM's eulogies, what do we find? JORDANUS is attempting to prove the known fact that when the weights are inversely proportional to the length of the lever arms, the lever is in equilibrium. The method is by means of the following diagram—or rather the following diagram is probably what the original author had in mind, for all the actual manuscripts and books consulted falsify the diagram in one or more respects. The lever (see figure 2) is *acb*, with *bc* the shorter side and *b* the proportionately heavier weight. The distance $cl = cb$ is then marked off along *ca* and at *l* a weight equal to *b* is attached. The lever is then assumed to rotate into an oblique position, with the point *b* at *e*, the point *a* at *d*, and the point *l* at *m* in the line *dmce*. From *d*, *m*, and *e* the perpendi-

culars *df*, *mg*, and *eh* are erected on the line *acb*. It is then shown that *mg* is to *df* as *mc* is to *cd*, or as *cb* is to *ac*, or as the weight *a* is to the weight *b*. Since the weight *l* is equal to the weight *b*, therefore *mg* is to *df* as the weight *a* is to the weight *l*. The argument then is that "what is sufficient to raise the weight *a* to *d* would be sufficient to raise the weight *l* to *m*"—in other words that the inner weight, *l*, which is heavier, would naturally be raised

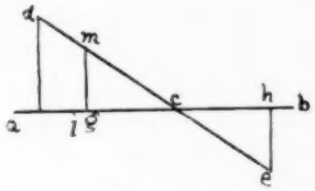

Fig. 2.

to a proportionately smaller height, so that *m* would be on the same line with the points *d*, *c*, and *e*. But, the argument continues, the weight *l* and the weight *b* are equal and at equal distances from the fulcrum, therefore *b* will be able to raise the equal weight, *l*, to *m*, and also *a* to *d*. "Hence the lever will return to the horizontal position (fiet redditus ad situm equalitatis)." In the extended JORDANUS manuscript, the last two statements are given in somewhat different form, to the effect that since *b* and *l* are equal and at equal distances, "*l* will not follow *b* in opposite motion, nor will *a* follow *b* in such motion."

It may be freely admitted that there is in this demonstration the germ of a correct proof of the lever by the principle of virtual work. But as it stands it is surrounded with obscurities. In the first place the implicit principle upon which the demonstration is based is not set up as a fundamental axiom or postulate, whose truth is to be accepted as self-evident and upon which specific demonstrations are to be based. This is all the more necessary in view of the fact that the content of the lever law was universally known, as were also known several demonstrations. If a new demonstration was to be attempted, its value can only lie in the introduction of a clear universal principle, not in a piece of *ad hoc* reasoning. It is to be noted that in the case of the pseudo-Aristotelian *Mechanical Problems*, the writer presents the basis of his lever demonstration—to which many objections may

be taken—as a universal principle, by which he seeks to demonstrate not only the lever but also other machines, like the pulley and the wedge. There is nothing like that in JORDANUS, although, as we shall see, DUHEM tries to make a case that the bent lever and inclined plane demonstrations of the "disciple" involved implicitly the same principle. A more serious difficulty lies in the handling of the virtual character of the principle of work. The lever is presumed to go through a finite displacement, and then it is presumed to return to horizontal balance—an allusion to the incorrect proposition that a lever with equal arms and equal weights *must* return to horizontal position.

How much superior was the handling of this problem by DESCARTES, who was the first to introduce the idea of infinitesimal displacements, is obvious to anybody, and is indeed recognized by DUHEM when he comes to deal with DESCARTES. But the real question is whether DESCARTES in his enunciation of his general principle or in his application to the lever problem was in any way indebted to JORDANUS' groping demonstration. From DUHEM's own discussion of DESCARTES' work, it appears 1) that DESCARTES developed his principle of virtual work (or rather what under a more precise rendering became the principle of virtual work, for DESCARTES used the loose concept of force rather than work) after the popularization of the principle of the inclined plane by STEVINUS and GALILEO; 2) that after demonstrating the principle of work as exemplified in the inclined plane DESCARTES applied it to pulley machines, where he may have undergone the influence of STEVINUS and GUIDO UBALDO del Monte; and 3) that he finally applied it to the lever by regarding the motion of a lever under a rupture of equilibrium as along an infinitesimal arc which represents an inclined plane.

Since the Cartesian enunciation of the principle of virtual work thus came as a result of the theory of the inclined plane and utilized a method entirely different from that of JORDANUS in the demonstration of the lever, the connection between DESCARTES and JORDANUS on this point would appear to be of the slightest, even if, as DUHEM maintains, DESCARTES was aware of JORDANUS' demonstration of the lever. DUHEM, however, seeks to establish that JORDANUS' supposed principle of work developed a tradition. One of the first fruits of that tradition was the demonstration

of the inclined plane by JORDANUS' disciple—or as we should maintain here, by JORDANUS himself. DUHEM's claim on this point is indeed curious. On the one hand, he maintains that this demonstration of the inclined plane—which is, as we have said, scientifically correct—is based on the notion of *gravitas secundum situm*, which he admits not to have entered into JORDANUS' demonstration of the lever with its supposed anticipation of the principle of work. On the other hand, he maintains that though the implicit enunciation of the principle of work was not based on the notion of *gravitas secundum situm*, it yet contributed to the demonstration of the inclined plane which was based on that notion. The fallacy in the claim is this : if JORDANUS or his supposed disciple had possessed clearly the principle of work he would not have needed the notion of *gravitas secundum situm* to demonstrate the law of the inclined plane. And if he used the notion of *gravitas secundum situm* he needed no other basis to complete his demonstration—and in fact used no other notion. How then does DUHEM establish his point? By playing on the fact that any demonstration of the inclined plane already foreshadows or implicitly involves the principle of work. In this way he is able to say that the demonstration by means of *gravitas secundum situm* involved also JORDANUS' principle of work.

To make the point clear, a brief summary of the actual demonstration may be set down. It is to be remembered that the axiom or postulate of *gravitas secundum situm* is that a weight is positionally heavier if its line of motion is more nearly vertical, or if the line of motion " takes more of the vertical " for a given distance. The author, before tackling his theorem (that two weights joined by a pulley along different inclines will balance if the weights are proportional to the " declinations," the size of the declinations being measured by the amount of horizontal distance involved in a given length of incline), first demonstrates that along the same incline a weight has everywhere the same virtue or power—presumably if we confine ourselves to statical considerations alone. Then he erects a figure with three inclines proceeding from the same vertex (see Figure 3). In this figure the two inclines to be contrasted are *dc* and *da*, with *dc*, the larger and flatter incline, further away from the vertical, *db*. A third incline, *dk*, is introduced for auxiliary purposes equal to *dc*,

and thus lies on the same side of the vertical as *da* but at greater distance. It is required to be proved that two weights, *e* and *h*, lying along the inclines *dc* and *da* respectively, and proportional to the declinations of these inclines (the larger weight on the flatter incline), will balance. A weight *g* equal to *e* is introduced along the incline *dk*. It is then shown that the weight *e*, when operating against the equal weight *g*, might be supposed to move

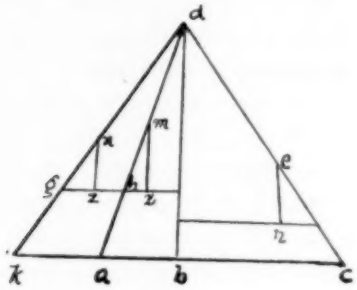

Fig. 3.

g a certain linear distance *gn*, which is equal to the linear distance traversed by *e* on its incline, namely the distance *el*. These two linear distances take equal vertical heights (*nz* and *er*). On the other hand, when *e* operates against the smaller weight *h* on the steeper incline, it will make *h* move the same linear distance *hm*, but with a *greater vertical distance*, *mx*. Now *e* will balance *g*, which is an equal weight taking in its line of motion the same amounts of vertical; therefore *e* will also balance *h*, which is a smaller weight than *g* but which in its line of motion takes a proportionately larger distance on the vertical.

Thus the essence of the demonstration is that the *gravitas secundum* situm varies with the slope of the plane, a weight on a steeper plane having a greater power. Although it involves the idea of rupture of equilibrium or virtual displacement, that idea is included in the definition of *gravitas secundum situm*, and for that reason once the definition is accepted, there are no further difficulties, as there were in JORDANUS' demonstration of the lever. DUHEM, however, after citing the demonstration, adds (*Origines*, I, p. 147) : " La démonstration est calquée sur celle que JORDANUS a donnée de la loi d'équilibre du levier; elle met en jeu le même postulat implicite : *Ce qui peut élever le*

poids P *à la hauteur* H, *peut aussi élever le poids Pλ à la hauteur* λH. Après avoir donné à JORDANUS une preuve convaincante de la loi d'équilibre du levier droit, ce postulat a permis au Précurseur de LÉONARD DE VINCI de résoudre les deux problèmes du levier coudé et du plan incliné". But from the demonstration we have cited, it is clear that there was no use of the principle of work in demonstrating the equilibrium on an inclined plane, and that it is only when read from a modern point of view that the proposition would be regarded as embodying this principle. DUHEM, not content with revealing the mediaeval enunciation of the correct solution of the inclined plane, wants to give the mediaevals credit for having made that discovery on the basis of a universal principle of work which only came after the acceptance of the inclined plane proposition.

But while the author of the inclined plane demonstration —whether it be JORDANUS or somebody else—does deserve the credit for giving the first correct solution of the problem, DUHEM himself shows elsewhere in his work that it was not accepted by fifteenth and sixteenth century science. For DUHEM the reason for this non-acceptance was the blind Renaissance prejudice against mediaeval thought, but it is perhaps more reasonable to suppose that the general obscurity of the JORDANUS manuscripts and the presence of so many erroneous propositions served to conceal the truth of this proposition. Whatever be the reason, the inclined plane demonstration was rejected : it was rejected or ignored by REGIOMONTANUS; it was rejected by GUIDO UBALDO del Monte (who accepted instead the erroneous solution of PAPPUS OF ALEXANDRIA); it was rejected by BENEDETTI; it was rejected or ignored by CARDAN, who himself elaborated a false solution of the problem. The only one who accepted the JORDANUS demonstration was TARTAGLIA, who plagiarized it boldly from the JORDANUS manuscripts and passed it off as his own. But even this act of plagiarism did not serve to recommend the stolen property to the sixteenth century mathematicians. It was at length accepted by HERIGONE in the seventeenth century, but only after STEVINUS and GALILEO's demonstrations had already been popularized.

Our findings so far may be summarized thus : DUHEM tries to show that JORDANUS foreshadowed the great Cartesian principle

of vitrual work in his demonstration of the lever. We have shown, however, that there is no universal principle involved in that rather obscure demonstration, and that DESCARTES, when he worked out his principle of work, had to use an artifice to make it applicable to the lever. DUHEM has next tried to show that this implicit principle of work was involved in the demonstration of the inclined plane by the so-called disciple of JORDANUS. We have shown that the demonstration, while correct, did not utilize any universal principle, and secondly that this demonstration did not pass into the general current of sixteenth century science.

But DUHEM still has a third line of argument to support the influence of JORDANUS and his supposed school on modern statics . Granted that the inclined plane demonstration was not accepted by the sixteenth century scientists, the influence of the school of JORDANUS passed into the work of LEONARDO DA VINCI, and from LEONARDO through CARDAN to STEVINUS and GALILEO. Everybody knows, of course, the difficulty of tracing a current of influence through LEONARDO, since it is a question of showing that the great Florentine's manuscripts were providentially plagiarized and his stray and contradictory thoughts always fell into the right hands for proper scientific development. But DUHEM himself destroys what little force there is to the whole argument when he asserts in his *Études* that LEONARDO did not have at his disposal a JORDANUS manuscript with the inclined plane and bent lever demonstrations and when he attributes the last three books of the extended JORDANUS manuscripts to the work of a follower of Greek traditions. From these assertions it would seem that the only proposition of JORDANUS and his supposed disciple that could have influenced LEONARDO was the demonstration of the lever law, and even DUHEM does not attempt to trace such a line of influence.

In addition to trying to show an influence on the formulation of the principle of work, DUHEM has also tried to trace the influence of JORDANUS and his school on the principle of statical moment. Although much of the force of his argument is broken by his own change of views, it is worth while analyzing his arguments as an example of his method. As we have mentioned above, the larger JORDANUS version, such as is the basis of the printed text of 1565, contains a correct enunciation of the equilibrium

of equal weights suspended to the unequal arms of a bent lever at equal distances from the vertical. The basis of the demonstration is that if the weights are presumed to move, one weight would have to be raised a greater vertical height than the other would be lowered, and as this is impossible the weights must balance. DUHEM as usual tries to see behind this demonstration the influence of the implicit principle of work involved in JORDANUS' demonstration of the lever, thus making it more and more of a mystery as to how JORDANUS and his disciple could be constantly using this principle but never stating it as a principle. The bent lever proposition is tied up by him with several propositions in the third book of the disciple (later attributed to the work of a follower of Greek science), in which there is involved implicitly a generalization of the law of the bent lever for unequal weights. DUHEM after summarizing these propositions then goes on to say that this is equivalent to the knowledge of the notion of moment, and that in another proposition this notion is actually utilized. In his own words :

" Ces règles peuvent encore s'énoncer ainsi : L'effet d'un poids qui pend à l'extrémité d'un bras de levier incliné d'une manière quelconque est mesuré par le moment de ce poids par rapport à la verticale du point d'appui. [See Figure 4.]

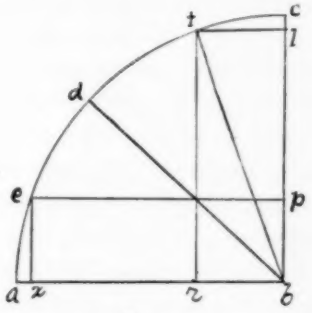

Fig. 4.

Cette manière d'envisager les problèmes dont nous venons de parler n'échappe point à notre auteur. " Si, dit-il, on soulève un fardeau, et si l'on connaît la longueur de son support, on peut, en toute position, déterminer ce que pèse ce fardeau... Le poids de ce fardeau porté en *f* par le support *bf* sera au poids porté en *e* par *eb* comme *fl* est à *fr* ou comme *pb* est à *xb*... Le poids placé en *f* à l'extrémité du levier *bf* pèsera comme s'il était en *u* sur le levier *be*.' "

When one turns to the actual text, one finds that the proposition in question refers to the lifting of the weight of the bar itself,

one end of which is fixed and the other movable *(sit* ab, *ponderosum, et sit ubique equalis ponderis, situm equaliter, et fixo* b*)*. Under these circumstances the supports, which are supposed to measure the weight of the bar under different inclinations, would have to be regarded as rigidly fixed in the ground, the twisting effect being neglected, and only the downward pressure exercised by the bar being considered. With these reservations a certain sense can be given to the mediaeval writer's idea of measuring the weight of the bar in terms of the length of the support. But that sense in no wise corresponds to the writer's conception of a periodical or cyclical change of weight as the bar is supported in different positions,—that the bar becomes lighter as it moves from *a* to *e* (*e* being some point not clearly defined, but such that *ea* = *fc*), then continually heavier from *e* to *d* (the midpoint of the arc), then lighter again to *f*, where it is just as heavy as it was at *e*, and then continuing still lighter until it reaches *c*. *(Dico igitur semper levius fieri ab* a *in* e *et inde semper gravius usque ad* d; *inde autem levius fieri usque in* f *atque in* f *equale grave ut in* e, *et inde semper levius usque ad* c.*)* This statement, which reveals what the author intended to prove in this proposition, and which is scientifically completely false, is entirely omitted by DUHEM. The statements he does print are incidental statements extracted from the context of the false demonstration. The only apology he makes is in a footnote, in which he remarks that " en cette proposition, le copiste a introduit des erreurs qui, parfois, rendent méconnaissable la pensée de l'auteur." The statement which I have cited is given substantially the same in both the manuscripts I have consulted and in the printed text. If the statement is to be regarded as a fault of the copyist, then it becomes impossible to find out on the basis of the present text what the author had in mind, and we have no right to quote isolated phrases as indicating a clear knowledge of the principle of moment.

We turn to the influence of these propositions centering on the bent lever. DUHEM has sought to show a direct influence of the propositions from the third book on LEONARDO DA VINCI, even when he came to the conclusion that they no longer come from a disciple of JORDANUS but from an anonymous follower of Greek science. The influence on LEONARDO may be granted as a possibility, although its extent can easily be exaggerated,

but from that point to carry it further into modern science raises the question of the plagiarization of the Florentine painter's manuscripts. DUHEM of course maintains that whenever Italian mechanicians of the sixteenth century show any originality they must have gotten it as a result of rifling DA VINCI's manuscripts. In this way he tries to maintain that when BENEDETTI (who was acquainted with the work of JORDANUS but rejected his methods in favor of the clear-cut demonstrations of ARCHIMEDES) enunciates the rule of moments and gives a very simple demonstration of the general law of the bent lever, he took these ideas from LEONARDO, who in turn derived them originally from the mediaeval manuscripts. The idea that BENEDETTI, an engineer by vocation and a gifted student of Greek statics, might have been able to formulate these principles by himself does not seem to have entered his mind. Nonetheless in his *Études*, when he comes to the conclusion that the third book of the JORDANUS manuscript was written not by a disciple of JORDANUS but by a follower of Greek traditions, DUHEM maintains that these propositions stem from HERON OF ALEXANDRIA, whose *Mechanics*, discovered in 1894, reveal knowledge of the fact that when the lever arms are oblique it is the horizontal distance to the line of the fulcrum that has to be taken into account. In other words, the study of these oblique relations was next on the order of business of scientific statics, and was already adumbrated by HERON, the last important Greek mechanician. With or without the JORDANUS manuscripts that problem was bound to be investigated as soon as the revival of technical interest and Greek learning were to come together, as they did in the Renaissance.

The JORDANUS problem finds, then, a simple explanation in terms of the cultural conditions of the history of science. During the Middle Ages the scientific phase of the Greek heritage was maintained, but it was maintained at a low level of social interest. A writer like JORDANUS, who possessed a great deal of originality, managed to incorporate, along with erroneous ideas inevitable in the atmosphere of his time, several original demonstrations which were in advance of the achievements of the Greeks in that field. This work failed to germinate and bear fruit in the Middle Ages because not enough persons were interested in that line of investigation. Then came the Renaissance, when, among other

things, the plebean practical interests developed in the Middle Ages outside of the formal intellectual tradition came intellectually to the fore, and united with a humanistic revival of the Greek mathematical tradition. The originality of JORDANUS as expressed in his true propositions was misunderstood because of the general mediaeval atmosphere of his writing, and the revived scientific tradition had to rediscover the propositions which JORDANUS had already discovered. This time, however, the cultural conditions were ripe for a sustained revival of science, and the work resumed in the Renaissance has not yet been interrupted.

The episode of JORDANUS, so far from proving mediaeval participation in modern science, as DUHEM claims, proves in reality just the opposite thesis.

BENJAMIN GINZBURG.

Johann Virdung of Hassfurt again

In his article, " Formula," published not long since in *Isis* (1), ALEXANDER BIRKENMAJER devoted much space to JOHANN VIRDUNG of Hassfurt (c. 1485-c. 1535) concerning whose life he stated that we still lack sufficient information (2), although he himself supplied a number of details. It is my purpose to present some further data as to VIRDUNG's career and character from manuscripts which were once owned by him or were written in his own hand. BIRKENMAJER alludes to one of these, Vatic. Palat. lat. 1369, which was presented to VIRDUNG by a LEONHARD LUYSER in Boppard (3). But in examining recently a number of manuscripts of the Palatine collection at the Vatican I noted two others which were copied in whole or part by VIRDUNG himself. This suggests that after his death his manuscripts passed into the library of the Elector Palatine at Heidelberg and that very likely more of them may in time be identified among the codices of the Palatine collections in the Vatican library (4) and in the Biblioteca Nazionale at Florence (5). Those that I have seen furnish additional dates in VIRDUNG's life or by their contents show the sort of works in which he was interested. Hitherto the preface to his *Tabulae resolutae*, published posthumously in 1542, has constituted the chief source of information concerning his life. Of VIRDUNG's annual astrological predictions during the fifteenth century, from

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(1) *Isis*, XIX (1933), 364-378.

(2) *Ibid.*, p. 365, " ... sind wir noch immer nicht ganz genau unterrichtet."

(3) *Ibid.*, p. 367, note 14, citing FR. SAXL, *Verzeichnis astrologischer und mythologischer illustrierter Handschriften des lateinischen Mittelalters in römischen Bibliotheken*, Heidelberg, 1915, p. 16.

(4) Unfortunately there are no recent and reliable catalogues as yet printed for the Palatine MSS. at the Vatican.

(5) *Ministero della pubblica istruzione, Indici e cataloghi*, IV. *I codici Palatini della R. Biblioteca Nazionale Centrale di Firenze*, vol. II, Fasc. 1-6, Rome, 1890-1899.

1487 to 1500, I have treated briefly elsewhere (6). It may be useful to add here for the sake of completeness some account of such works by him printed during the sixteenth century as I have been able to examine.

Vatic. Palat. lat. 1375 is a manuscript written in VIRDUNG's own hand (7) and containing several specific dates in his career. On the flyleaf is a note recording the visit in 1520 from Monday to Wednesday following the feast of St. James of a NICHOLAS OF FAIRMOUNT, an excellent British astrologer and nigromancer who was further a priest and doctor of laws (8). This entry, made by VIRDUNG long after the writing of the rest of the manuscript, accords well with his own visit to England in 1503 " to learn magic " (9) and suggests that his interest in such subjects was perennial.

The other dates of the manuscript are those of VIRDUNG's copying different works contained in it. In 1488 at the university of Cracow he copied the *Canons* of GIOVANNI BIANCHINI (10), and from June 12 to July 20, 1488 he copied BIANCHINI's astronomical tables (11). During the same year he further copied the *Equatorium* of JOHN DE LINERIIS (12) and a list of works left by REGIOMONTANUS at Nürnberg, and drew up a table of fixed stars with their positions (13). These activities indicate that

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(6) *History of Magic and Experimental Science*, IV (1934), 456-7.

(7) In the top margin of fol. 1 r. we read, " Liber magistri IOANNIS VIRDUNGI de hasfurt scriptus manu ipsius Cracovie." As we shall see, however, the later items in the MS. were added years after at Heidelberg.

(8) " NICOLAUS de Pulchro monte Schonberg Britannus astrologus optimus et nigromanticus fuit mecum Anno 1520 die ♃ post IACOBI et recessit die ☿ erat presbiter et doctor legum." The days of the week are indicated by their planetary symbols. I have not been able to find any further account of this NICHOLAS.

(9) BIRKENMAJER, p. 366, citing G. BAUCH, *Deutsche Scholaren in Krakau in der Zeit der Renaissance*, Breslau, 1901, p. 33.

(10) Vatic. Palat. lat. 1375, fol. 8 v., col. 1, " Expliciunt Canones magistri IOHANNIS DE BLANCHINIS de veris motibus planetarum studio in Cracoviensi anno 1488 imperfecto. Deo gratias."

(11) *Ibid.*, fol. 185 r., " Anno 1488 12 die Iuni incepi scribere tabulas istas BLACHINI et eas finivi 20 die Iulii anno etc. Et hoc in inclito Cracoviensi gymnasio."

(12) *Ibid.*, fol. 10 v., col. 1 : " Explicit Equatorium planetarum secundum magistrum IOANNEM DE LINERIIS anno domini 1488 (in)completo in studio Cracoviensi per magistrum (?) Iohannem de Hasfurth finitum."

(13) *Ibid.*, fol. 176 r., col. 2 : " Finis stellarum fixarum a.d. 1488 in studio

VIRDUNG remained at Cracow after receiving his baccalaureate there in 1486 (14), although he was to take his master's degree at Leipzig on December 28, 1491 (15). The next dates in our manuscript, however, find him at Heidelberg. At its " illustrious university " in 1493 he copied the tract of PHILO on subtle or spiritual engines (16). Since this work occurs anonymously in the manuscript given to VIRDUNG by LUYSER at Boppard (17), it seems probable that that presentation had not yet been made in 1493. Two years later, still at Heidelberg, VIRDUNG copied a treatise on the composition of the cylinder (18).

VIRDUNG's interest in magic is further attested by a tract in this same manuscript on imprisoning spirits of the planets in rings by using a metal and sacrificing an animal appropriate to the planet as well as by employment of exorcisms, characters and engravings on gems. The spirit will appear either in the form represented on the seal or in that of the decapitated animal, and will do whatever it is commanded (19). VIRDUNG probably got out the manuscript to show NICHOLAS OF FAIRMOUNT this treatise and afterwards recorded his visit on the fly-leaf. The manuscript also comprises works on astrological and magical images ascribed to Belemich, Hermes and others, and various other astronomical and astrological items.

Another manuscript, Vatic. Palat. lat. 1391, of some three hundred pages, is headed " The Book of Master JOHN VIRDUNG

Cracoviensi per me Baccalaureatum Io. de Hasfurth." The list of works brought to Nürnberg by REGIOMONTANUS follows at fol. 176 v. with the date " 1488 " at its close.

(14) BIRKENMAJER, p. 365, says : " Im Winter 1487 kehrte er nach Leipzig zurück." Either this is erroneous or VIRDUNG returned to Cracow again the next year.

(15) *Idem.*

(16) Vatic. Palat. lat. 1375, fol. 181 r. : " Explicit liber PHILONIS de subtilibus ingeniis in inclito studio Heidelbergensi anno 1493 dominica post viti per magistrum Io. VIR. de Hasfurt."

(17) Vatic. Palat. lat. 1369, fols. 140 r., col. 1-141 v., col. 1 : " In nomine domini py et misericordissimi de spiritualibus ingeniis... / ... Explicit liber ingeniorum."

(18) Vatic. Palat. lat. 1375, fol. 183 v. : " Explicit compositio et utilitas chilindri Anno 95 Heydelberg in vigilia palmarum per magistrum IOANNEM VIRDUNG de Hasfurth."

(19) *Ibid.*, fols. 269 v.-270 r. : " Incipit liber de spiritibus inclusis."

of Hasfurt." First occur *Canons of the Primum Mobile* (20) of which the quires of twelve leaves each are done by alternating hands. Then astronomical tables follow (21). But the next item in the manuscript, on the astronomical instrument Albion in four treatises, is copied in VIRDUNG's own hand with a statement at its close that he finished it at the university of Heidelberg the Sunday after Dionysius's day in the year of Jubilee 1500 (22). Thus VIRDUNG owned at least two copies of the work *Albion*. Since the *Albion* is also contained in the manuscript donated by LUYSER (23) and VIRDUNG would hardly have gone to the trouble of making a fresh copy of the entire work if it was already in his possession, it would seem that LUYSER's gift was made after 1500. A few more pages in VIRDUNG's writing follow on the subject of the projection of a sphere on a plane surface (24) and then for near a hundred pages the hand changes and we have some mathematical work (25) and both Latin and German text on the measuring of casks (26), followed by figures to illustrate. Presently comes a figure of a horoscope for "a young duchess" (?) born on October 11, 1499 (27), and then an *Invective* against superstitious astrologers which seems to be in VIRDUNG's handwriting and possibly is his own composition (28). Like the copy of *Albion* it is dated in 1500. Yet we are surprised that he should

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(20) Vatic. Palat. lat. 1391, fols. 1 r.-59 v., "Generalem tabule usum in primis explanere... / ... *Περίοδος καὶ Τέλος* horum canonum primi mobilis."

(21) *Ibid.*, fols. 61-149, followed by blank leaves 150-156.

(22) *Ibid.*, fols. 157 r.-195 v., "Albion est geometricum instrumentum... /... Finis Albionis per me magistrum IOANNEM VIRDUNG de Hasfurt in gymnasio Heydelbergensi dominica post Dyonisii Anno Iubileo 1500."

(23) Vatic. Palat. lat. 1369, fols. 1 r.-53 v.

(24) Vatic. Palat. lat. 1391, fols. 195 v.-198 r., Rubric, "Proiectio sphere in planum"; incipit, "Concussio sive extensio ymo pocius proiectio sphere in planum..."

(25) *Ibid.*, fols. 199 r.-278.

(26) *Ibid.*, fols. 279 r.-285.

(27) *Ibid.*, fol. 293 *a*, recto.

(28) *Ibid.*, fols. 294 r.-299 r., "Prologus in posicionem contra supersticiosos astrologos fœliciter editam anno 1500." Incipit, "Multi astrologorum superstitiosorum virorum superba curiositate ac vicio cupiditatis execrati peccatis onerati in fide Christi reprobi in vanitate sua pertinaces..."

Ending, "... Laus deo glorioso cuius infinita misericordia presens opusculum est completum anno 1500." Another line of text follows which I could not decipher.

even have copied, to say nothing of composing this *Invective*, since it seems unfavorable to the art of astrology itself which he professed and practised and is not merely directed against certain superstitious astrologers. It opens with the assertion that many astrologers are guilty of the sins of pride, curiosity, and cupidity, are remiss in the Christian faith and pertinacious in their vanity. It is objected against them that they try to determine the exact date of each man's death and predict particulars when the influence of the sky is general. They also err in predicting events of which man himself is the cause and it is suggested that their true prognostications may be rather the work of demons. Princes, spiritual and secular, are exhorted against them, the Bible is quoted against them, and it is affirmed that hope should be reposed in God alone and not in the stars. It is true that the sixth and last chapter discusses how far it is licit as well as illicit to predict the future, and that earlier the noble science of " astronomy " has been declared very different from superstitious astrology. But the third chapter suggested that it might be better for a Christian to pass by astronomy as well as astrology. Altogether the attitude of the *Invective* is Christian rather than scientific.

In 1503 VIRDUNG printed at Strasburg a *Practica* in German addressed to PHILIP, the elector palatine, dealing especially with the effects of the conjunction of Saturn, Jupiter and Mars in Cancer (29). The work fills twenty-one leaves with many pictures. It is divided into Distinctions, of which those from the third to the ninth treat of the advent of a prophet who will appear soon after this conjunction. Distinctions ten to twelve then deal respectively with failure of the crops, pests, wars and states. Five Distinctions then treat of a comet and the eighteenth Distinction reviews past examples for some eight pages. Upon many points VIRDUNG is content simply to state the varying views of ALBUMASAR, HALY, MESSAHALA, PTOLEMY and others.

To PHILIP's successor, LUDWIG, as elector palatine, VIRDUNG addressed a discussion of wonderful signs in the sky—three moons

(29) JOHANN VIRDUNG, *Practica Teütsch Etlich Jar werende... uss d' grossen Conjunction der dryer öbersten Planeten... gezogen. Von d'zükunfft eins neüwen Propheten und anderer grössen geschicht. Mathis Hüpfuff.* Strassburg, 1503.

with a cross in the middle and largest one—seen in 1514 in Wurtemberg (30). He argues that they were the work of nature giving different reasons from ARISTOTLE and the perspectivists (i.e. writers on perspective) and preferring the explanation of the latter in this case. Then comes an exposition of the astrological significance of these signs. They more concern the common folk than they do the magnates and indicate that the former will conspire against the latter as never since 1390. VIRDUNG also, as in his work of 1503, cites past examples, going back to the 570th year after the founding of Rome. There were three moons with a cross back in 1160 when there was an antipope. And the king of France should beware lest the happenings of the year 1314 recur.

In 1520 VIRDUNG wrote on a similar theme, meteoric apparitions, at Vienna from January 3 to 7 of that year (31). HELLMANN regarded it as the most important of the *Flugschriften* elicited by these phenomena and characterized it as " ein erster Grundriss der meteorischen Optik " (32). VIRDUNG also regarded these signs in the sky as a warning of what the stars would effect in 1524.

Of this coming conjunction of 1524 he treated in a *Practica* dated from the university of Heidelberg on November 11, 1521 (33), and dedicated to the emperor, CHARLES V, as well as to the elector Ludwig. A letter to an ADAM WERNHER von Themar or Chemar, doctor of both laws, seems to refer to a *Practica* in Latin verse, but the versions I have seen were in German. VIRDUNG states that the effects of the conjunction will endure for forty years until 1563. Some things indicated by it will begin after thirteen years and last for five years and four months. Others will begin

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(30) *Die ausslegung magistri Iohannis Virdung von Hassfurt... über die wunderbahrlichen zeichen die do gesehen worden sein bey dem Mon uff dem Schloss hohem urach im Wirttenberger landt im M.ccccc.xiiii Iare am dinstag nach Erhardi frwe umb drey uren do der Scorpion im anfang der Sonnen gesehen wart. Gedruckt durch iacob Schmyeden zü Spyer von wegen Arnolt Schlicken Pfalzgravischen Organisten uff sein Kaiserlich freyheidt und mandaten nicht nach zu drücken.*

(31) *Ausslegung und Beteutung der Wunderbarlichen zeichen*, Oppenheim, probably 1520.

(32) G. HELLMANN, *Beiträge zur Geschichte der Meteorologie*, Berlin, 1914. Pp. 14-15.

(33) *Practica Teütsch über die neüwe erschröckliche vor nie gesehen Coniunction... im Iare M.CCCCC.XXIIII...* Gedruckt zu Oppenheym, 1521.

after fifteen years in 1540 and last five years and eight months. Others will begin after twenty years and last for eight years. Others will begin after 1553 and last until 1563; others, after 1556 and last five years and four months. But VIRDUNG fears that some significations of this conjunction will be felt already in 1523 before it, and others in the very year of the conjunction, 1524, notably excess of waters destroying the fruits of the earth and ships at sea. He believes there will be a small partial deluge like that in Achaea in the time of the patriarch Jacob, or in Thessaly at the time of Moses, when men fled to the slopes of Parnassos, but not a universal flood like that in the days of Noah, nor even so large as to inundate an entire kingdom. About 1526 this work of VIRDUNG was reprinted at Strasburg together with the older popular prophesy of LICHTENBERGER or " Bilger Ruth " from the conjunction of 1484 and solar eclipse of 1485 (34). In 1542 it was again printed at Augsburg with the prophecy or *Weissagung* of JOHANN CARION for the years to 1560 (35).

We have another *Practica* in German by VIRDUNG for the year 1529 addressed to the elector LOUIS and presumably printed at Heidelberg in 1528 but without naming the place, date or printer. An illustration shows an armed man with three goats on an orb or hill whose base is surrounded by men with rakes, pitchforks, spades, adzes, a cross and a staff, with three lines of verse at each corner of the picture. An imperial franchise forbids anyone else to reprint HANS Hassfurts *Practica* within six years (36).

Our next glimpse of VIRDUNG's literary activity and possibly the last to be printed during his lifetime is in the field of astrological medicine, *A New Method of Medicine Now First Composed and Edited from Mathematical Ways of Curing Diseases*, printed at Ettelingen by VALENTIN KOBIAN in 1532. As a matter of fact there does not seem to be anything very novel about the book

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(34) *Ausslegung der Coniunction aller Planeten in den Fischen anno MDXXIIII geschehen :* the copy I have used at the British Museum was BM 8610.bbb.4.

(35) *Practica vom XLIII Jar an biss man zelt LXIIII... Practiciert auss der grossen Coniunction der Planeten in den Fischen, Anno* 1524 *etc. :* the copy used was BM 8610.cc.1.

(36) *Practica deutzsch... uff das Mccccxxix jare gemacht :* copy used, BM 1395.g.24.

which much resembles other works of astrological medicine. VIRDUNG says that he was impelled to write it when he noticed that many students in medical faculties of his day spent many years without learning human constitutions, the causes of diseases, critical days, sure judgment of urines, and the proper seasons to evacuate humors. The book is in four parts. First the principles of astronomy needed in medicine are considered in eight chapters; then the principles of the medical art in twenty-eight chapters; third, critical days in six chapters; and finally, judgment of urines in seven and eight chapters (37).

This work of 1532 was reprinted at the Hague next year and at Venice in 1584 with comments of IOANNES PAULLUS GALLUCIUS SALVENSIS and dedicated to the bishop of Modena (38).

Written probably later than the foregoing work of 1532, but not published until after VIRDUNG's death as a preface to his *Tabulae resolutae*, was the letter in which he turned this work over to JACOBUS CURIO and asked him to edit it. It was a handy manual which CURIO, when his disciple twenty-four years since, had asked him to prepare, which VIRDUNG had carried with him on his distant travels as his sole astronomical and astrological work of reference. Now his friends urge him to publish it for the general benefit, but he lacks the leisure and good health to undertake its revision " in this weakness of my declining age." He therefore asks CURIO to do this for him. He admonishes him not to bother concerning matters of style too much, and expresses the opinion that CURIO is no longer the foe of the Arabic astrologers he formerly was, recalling a disputation which they once had on that point.

BIRKENMAJER has shown that VIRDUNG was certainly dead by 1542 and places his decease tentatively around 1535. A prognostication for the year 1542 which in the British Museum catalogue

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(37) *Nova medicinae methodus nunc primum et condita et aedita ex mathematica ratione morbos curandi*, Ettelingae An. MDXXXII. Impressum per VALENTINUM KOBIAN anno natalis Christi millesimo quingentesimo tricesimo secundo mense Februarii.

(38) *J. Hasfurti... de cognoscendis et medendis morbis ex corporum coelestium positione libri iiii. Cum argumentis et expositionibus J. P. Gallucii... Quibus accesserunt in eandem sententiam auctores alii.* See KARL SUDHOFF, *Iatromathematiker vornehmlich im 15. und 16. Jahrhundert*, Breslau, 1902, p. 51.

was attributed to JOHANN VIRDUNG himself turned out upon inspection to be by his cousin and disciple, JOHANN VIRDUNGEN (39) It was probably through a like confusion that HELLMANN made VIRDUNG's annual predictions continue until 1543 (40).

(Columbia University, New York.) LYNN THORNDIKE.

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(39) *Practica oder predictiones Teutsch auff das MDXLII jar. Durch des Hocherfarnen Doctor Johan Virdung von Hassfurt seligen Discipulen und Vettern Johan Virdungen gezogen aus dem lauff des Gestirnes zu ehren der löblichen Hohen Schul Mentz.* Gedruckt zu S. Victor bey Mentz durch FRANCISCUM BEHEM. MDXLII. 8 fols. 4to. BM 1395.h.53.

(40) G. HELLMANN, *Versuch einer Geschichte der Wettervorhersage im XVI. Jahrhundert, Abhandlungen d. Preussischen Akademie d. Wissenschaften, Jahrgang* 1924, *Physikalisch-Mathematische Klasse*, p. 30.

Joseph Black's Lectures on the elements of chemistry

Introduction

Joseph Black (1728-1799) was Professor of Chemistry at the Universities of Glasgow (1756-1766) and Edinburgh (1766-1799). Immediately after his death, his executors decided to publish his lectures from his manuscript notes. This step was taken as they were informed that publication was proposed from notes taken by his students, copies of which were in circulation (1). The best of these was considered so unworthy of Black that the executors wished to prevent the inadequate impression of his knowledge and talents which such a publication would make.

John Robison, LL.D., Professor of Natural Philosophy at Edinburgh, was recommended as one who would be most likely to do justice to Black's reputation. Robison was a student of Black's at Glasgow in 1758, succeeded him there in 1766, and became one of his colleagues at Edinburgh in 1774.

In compiling and editing the *Lectures on the Elements of Chemistry*, Robison used, in addition to Black's manuscripts, a copy of a student's notes which had belonged to Black, and in which he had made many alterations and additions. He also consulted the memoranda of experiments, quotations from authors, speculations, etc., which Black had made and preserved.

The *Lectures* were published in 1803. The work is in two volumes, quarto, and is indexed. The Editor is responsible for occasional foot-notes and more copious notes at the end of each volume. The contents are arranged as follows :

(1) Indeed such misadventure had happened to Hermann Boerhaave, the spurious publication of whose lectures on chemistry, *Institutiones et experimenta chemiae*, in 1724 obliged him to prepare the authentic edition, Leiden, 1732. See Tenney L. Davis : The vicissitudes of Boerhaave's Textbook of chemistry (*Isis* 10, 33-46, 1 pl., 1928).

Vol. I. (a) Dedication and preface by the Editor, followed by some general observations on chemistry.
(b) Effects of heat.
(c) Effects of mixture.
(d) Apparatus.
(e) " Salts " (this includes acids and alkalies).
Vol. II. (f) Earths.
(g) Combustible substances.
(h) Metals.
(i) Various types of water.
(j) Editor's notes, Index, Plates.

LECTURES

ON THE

ELEMENTS OF CHEMISTRY,

DELIVERED

IN THE UNIVERSITY OF EDINBURGH,

BY THE LATE

JOSEPH BLACK, M.D.

PROFESSOR OF CHEMISTRY IN THAT UNIVERSITY,

PHYSICIAN TO HIS MAJESTY FOR SCOTLAND; MEMBER OF THE ROYAL SOCIETY OF EDINBURGH, OF THE ROYAL ACADEMY OF SCIENCES AT PARIS, AND THE IMPERIAL ACADEMY OF SCIENCES AT ST. PETERSBURGH.

NOW PUBLISHED FROM HIS MANUSCRIPTS.

BY

JOHN ROBISON, LL.D.

PROFESSOR OF NATURAL PHILOSOPHY IN THE UNIVERSITY OF EDINBURGH.

VOL. I.

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PRINTED BY ROBERT AND CHARLES DICKSON,

FOR LONGMAN AND REES, LONDON; AND WILLIAM CREECH, EDINBURGH.

1803.

(By courtesy of the British Museum)

VOLUME I

(a) DEDICATION, PREFACE, GENERAL OBSERVATIONS (I, i-lxvi, 1-21)

The work is dedicated by the Editor to JAMES WATT, " Dr. BLACK's most illustrious pupil."

ROBISON occupies seventy pages with his preface, which is mainly biographical. Three points of importance or interest are worth mention. At Glasgow University, BLACK was a pupil of

Dr. CULLEN (1710-1790) who " succeeded in taking chemistry out of the hands of the artists, the metallurgists, and pharmacists, and exhibited it as a liberal science, the study of a gentleman " (I, xxii). When BLACK graduated M. D. at Edinburgh in 1754, he submitted his now famous dissertation, *De Acido a cibis orto, et de Magnesia* (later published as *Experiments on Magnesia, Quicklime, and other Alkaline Substances*), a subject which had received his attention for the previous three years. His work on latent heat was carried out at Glasgow between 1759 and 1763. ROBISON states that he has been particular to include everything of importance and to correct any inaccuracies.

BLACK commences the *Lectures* by defining chemistry as " the science or study of those effects and qualities of matter which are discovered by mixing bodies variously together, or applying them to one another with a view to mixture, and by exposing them to different degrees of heat, alone, or in mixture with one another, in order to enlarge our knowledge of nature, and to promote the useful arts " (I, 11).

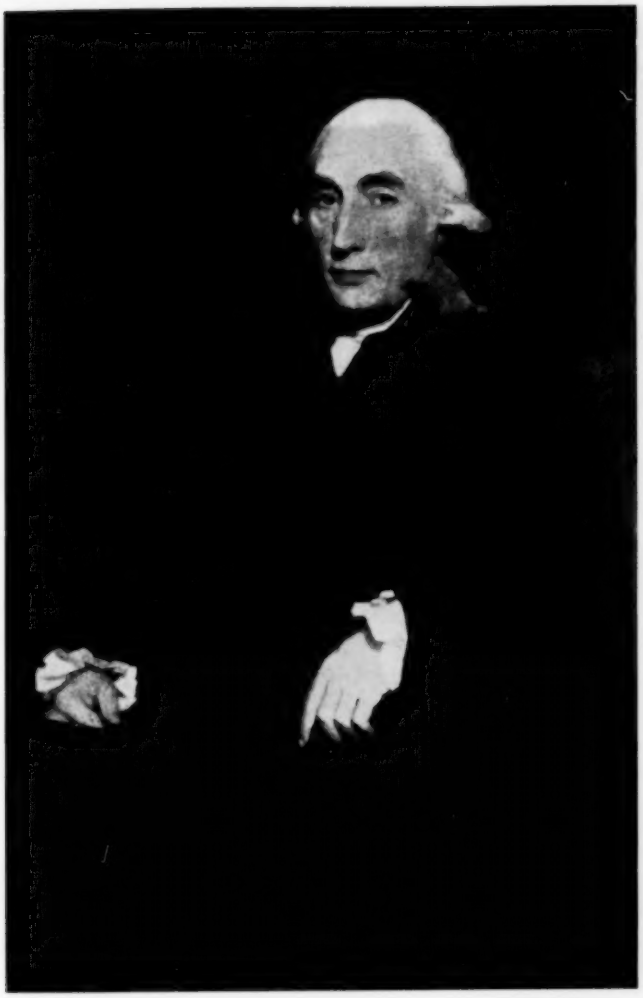
(b) EFFECTS OF HEAT (I, 22-247)

BLACK devotes pp. 24-247 to heat. His definition of chemistry, given immediately above, allows heat an importance which justifies the attention he gives it. His arrangement of this section is : (1) Meaning of heat; (2) Meaning of cold; (3) Nature of heat; (4) Effects of heat—expansion, fluidity, vapour and vaporisation, ignition, combustion.

Owing to his inability to come to a conclusion about the nature of heat, he states, " I propose to use the word (heat)... as expressing that state, condition or quality of matter by which it excites in us the sensation of heat."

BLACK disposes of MUSCHENBROECK's hypothesis, that cold like " caloric " was a definite substance, by arguing that the sun is the primary source of heat, and that no primary source of cold has yet been discovered.

FRANCIS BACON's induction that " heat is motion " is dismissed by BLACK, on the grounds that the evidence in support of it is insufficient, although it was accepted by his contemporaries, MACQUER (1718-1784) and FOURCROY (1755-1809). BLACK



JOSEPH BLACK

From the painting by sir HENRY RAEBURN (1756-1823), in the University of Edinburgh.

believed, with CLEGHORN (*De Igne*, 1779, pp. 40, 41), that " heat depends on the abundance of that subtile fluid elastic matter... possessed of another property also, that is, a strong attraction for the particles of the other kinds of matter in nature, which have in general more or less attraction for one another " (I, 33).

BLACK, while referring to the anomalous behaviour of water, iron and antimony, in that they contract when changed from the solid to the liquid state, raises the question of the ponderability of heat. He discusses the work of those who believed that heat had weight (MUSCHENBROECK, BUFFON, BOERHAAVE), and of those who satisfied themselves that hot bodies were no heavier than cold ones (ROEBUCK, WHITEHURST, FORDYCE). In his summing up, BLACK says that it has not been proved experimentally that the weight of bodies is increased by simply heating them, or by the presence of heat in them. He makes it clear that increase in weight on calcination is due not to heat, but to air.

Although he refers to the irregular expansion of water between 32° and 40° F., he attempts no explanation. BLACK devotes nearly 40 pages to the thermometer, dealing with the suitability of various liquids, methods of fixing points, scales of degrees, uses, etc. He relates how he verified the (almost) regular expansion of mercury with rise of temperature : he took the temperature of equal quantities of hot and cold water, mixed them, and took the temperature again. For the purpose of measuring temperatures outside the range of mercury thermometers, NEWTON's " cooling curve " method is described.

Throughout his lectures BLACK uses the word " heat " for " temperature," but he clearly distinguishes between " intensity of heat " and " quantity of heat." He believed that there was an absolute zero (I, 64).

Although spirits of wine had never been frozen, BLACK did not believe it impossible, because " we are sure that it still retained a quantity of heat " while it remained liquid. Under BLACK's direction, in 1783, HUTCHINS found that the freezing point of mercury was 40/41° below zero, using a mercury thermometer, and 30° below zero, using an alcohol thermometer. The experiment was carried out in Hudson Bay. These figures were confirmed, also at BLACK's instigation, by GUTHRIE in St. Petersburg in 1786/7.

BLACK recognises the independence of specific heat from other properties (I, 79). He named this property, " the capacity for the matter of heat," and states that it can only be ascertained by making experiments. He mentions that specific heat can be used in a method of determining high temperatures, as an alternative to NEWTON's method.

When considering the communication of heat, BLACK explains convection (although he does not use this term).

In the section dealing with " fluidity," he deals with his discovery and measurement of latent heat. He uses this expression because it is not shown by the thermometer. The two methods by which he arrived at his result for the latent heat of the fusion of ice —" 145 degrees of heat " (i.e. 81 cals./gm.)—are described. The temperature changes accompanying the freezing of super-cooled water, first observed by FAHRENHEIT, are used by BLACK to illustrate further his theory of latent heat.

The methods employed by BLACK, IRVINE and WATT for finding the latent heat of the vaporisation of water are described (I, 171-3). He also mentions how LAVOISIER obtained a value, using a calorimeter of his own invention, within 3 per cent. of the figure accepted today. BLACK makes no claim to be the inventor of what is often described as " BLACK's ice calorimeter."

ROBISON notes (I, 522-531) that the discovery of latent heat has been wrongly claimed for WILCKE, DE LUC, and LAVOISIER; he offers evidence giving BLACK ten years priority over any of the others.

Under the heading of combustion, BLACK deals with phlogiston, concerning which he says : " This exquisitely subtile and active matter, therefore, was, by the later chemists, supposed to be capable of being fixed and combined with other matter, so as to enter into the composition of certain bodies; and, in this combined and fixed state, gave to such bodies the quality of inflammability, and was separated from them during their inflammation. This is the opinion I had of it formerly, before the existence of a phlogiston, or principle of inflammability, began to be doubted." (I, 235). He gives LAVOISIER credit as the principal author of the new theory.

(c) EFFECTS OF MIXTURE (I, 248-285)

Although BLACK uses the word " mixture," most of this part of his work is concerned with chemical combination. He gives a clear concept of a compound, which has " all the appearance of being simple and homogeneous, or in which the eye cannot discover, even with a microscope, the smallest signs of any diversity in the constituent parts... the subjects unite with the appearance of violence, or with rapidity, commotion and the production of heat." He appreciates that compounds can only be separated by chemical means. Fixity of proportions he compares with saturation in solutions.

The mechanical explanations of combination associated with FRANCIS BACON, BOYLE and LEMERY are discussed, but dismissed as unsupported by any evidence in their favour. NEWTON is credited with first proposing the doctrine of chemical attraction. As no attraction is perceptible to the senses, the word " affinity " was substituted, although it wrongly implies a similarity, which is inconsistent with its meaning in chemistry.

In his explanation of *Elective Attractions*, BLACK states : " A third body frequently acts on a compound of the two ingredients so as to separate these from one another " (i.e., $AB + C = AC + B$, due to A having a greater affinity for C than for B). He explains GEOFFROY'S *Table*, and points out that the arrangement of substances may be affected by circumstances (such as heat) and by the quantity of " an attracting substance " (i.e., mass action).

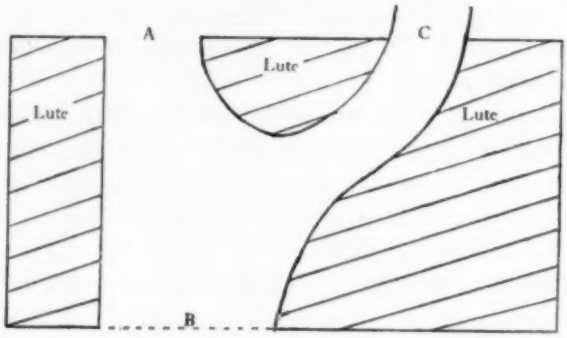
Cases of double decomposition, referred to as " double elective attractions " are next dealt with. His implicit acceptance of the law of constant composition comes out in his distinction between mixtures and compounds : the latter are " distinguishable by mutual saturation of the ingredients." ROBISON interpolates some general observations at the end of this section : he claims that the doctrine of chemical affinity is unquestionably the great and distinguishing principle of chemistry.

(d) APPARATUS (I, 286-346)

The lectures on this subject give a very good idea of the apparatus

and methods employed during the latter half of the 18th Century. BLACK here deals with the various types of vessels used, and the means of producing and applying heat. Vessels for preparing mixtures and solutions, crucibles, vessels for use on the water bath and for distillation, are described. Different varieties of fuels, and sources of heat, including lenses and mirrors, are included. Various furnaces, including one of BLACK's own invention, are described and illustrated.

Section of BLACK's furnace



Retorts, etc., can be placed on A, while fuel can be charged in at C. Crucibles can be placed at B, surrounded by fuel, while A is closed with a tile, and C is open to create a draught.

The remainder of the lectures—"the chemical history of bodies"—is devoted to the chemistry of the substances then known to man. BLACK anticipated modern methods of classification, by elements, but he appreciated that too little was known in his time. He admits that no classes in nature are distinctly defined, and adopts "the arrangement which has prevailed for some time past among chemists." He divides his subject matter into five main classes : salts, earths, inflammable substances, metals, waters. The subdivisions of these classes, he terms genera and species.

(e) "SALTS" (Class I) (I, 347-499)

BLACK defines salts as substances which are easily volatilised or melted by heat, soluble in water, non-inflammable, and

possessing a " sapid " taste. He included in this class the acids and alkalies.

The general properties of the *alkaline salts* (genus 1) are given as their action on vegetable colours, their peculiar taste, and their corrosiveness. BLACK does not make any clear distinction between the caustic and the mild alkalies, although the difference follows from his own discoveries; he does not include lime among them.

The genus comprises : *vegetable alkali* (species 1), or potash; *fossil alkali* (species 2), or soda; *volatile alkali* (species 3), or ammonium carbonate, also known as " spirit of urine," " salt of urine," " spirit of hartshorn."

Acid salts (genus 2) do not bear their present-day connotation; BLACK himself uses the word " acid " as a synonym. He first deals with the " fossil acids " (the three mineral acids), then with acetic, tartaric and boric acids. No mention is made of the purity, or purification, of these acids. The general properties of the acids are given as : a strong attraction for water, their action on vegetable indicators, union with alkalies causing effervescence, and powerful solvent action.

Among the reactions of *vitriolic acid* (species 1), BLACK gives some space to its effects on inflammable (organic) substances. According to him, it was reactions of this nature which led STAHL to introduce phlogiston. Much of this section is devoted to the phlogiston and oxygen theories. BLACK distinguishes sulphuric from sulphurous acid, and refers to the use of the latter for bleaching.

Nitrous acid (species 2) is impure nitric acid—the pure nitric acid is obtained by distilling off the fumes which the " nitrous acid " emits. Fuming nitric acid was known as " GLAUBER's spirit of nitre," and diluted nitric acid as *aqua fortis*. *Muriatic acid* (species 3) is described as yellow in colour. *Acetous acid* (species 4) was the name given to the dilute acid (vinegar). *Acid of tartar* (species 5) is also termed " tartarous acid " by BLACK; he believed that a stronger acid—tartaric—was yet to be obtained from it. Boric acid was known as *sedative salt*. BLACK notes that it can be separated from impurities on account of its volatility in steam. The alcoholic solution was also known to burn with a green flame.

The *compound or neutral salts* are the salts proper. Of their

formation, BLACK says, " Almost in every case the acid and alkali are capable of uniting firmly together, in one certain proportion only " (I, 415). Their distinguishing properties are given as : a neutral effect on indicators, a milder taste, a weak attraction for water, much less " acrimony." BLACK gives a table, the columns of which are " arranged according to the elective attractions of an alkali for the different acids " :

	Vitriolic Acid	Nitrous Acid	Muriatic Acid	Acetous Acid	Tartarous Acid	Sedative Salt
Vegetable Alkali	Vitriolated Tartar	Nitre	Sal Digestivus	Sal Diareticus	Tartar	. .
Fossil Alkali	Glauber's Salt	Cubical Nitre	Common Salt	. .	Rochelle Salt	Borax
Volatile Alkali	Vitriolic Ammoniac	Nitrous Ammoniac	Sal Ammoniac	Spiritus Mindereri	. .	. .

Vitriolated tartar (species 1) is potassium sulphate. BLACK explains that it is a by-product of the manufacture of nitric acid. *Glauber's salt* (species 2), sodium sulphate, is a by-product in the manufacture of hydrochloric acid. BLACK makes the subject of *nitre* or *saltpetre* (species 3) the occasion to introduce gunpowder, nitric acid and oxygen.

After making observations on the effect of heat on nitre, BLACK refers to the experimental work of HALES and MAYOW. Of the latter he says : " this author writes in an obscure mysterious manner, as too much practised in those days; but he has made many experiments, most ingeniously contrived, and has deduced from them conclusions which are nearly the same with the doctrines which have been more clearly established of late years." ROBISON, in a note at the end of the volume, discusses HOOKE's contribution to the subject, remarking that it is " most strange that it should have been so entirely forgotten " (cf. PATTERSON, *Isis*, 1931, 15, 47, 504). BLACK deals with the work of SCHEELE (who called oxygen, " fire-air," translated " empyreal air "), PRIESTLEY (who called it " dephlogisticated air "), and others (who named it " vital air "). Because LAVOISIER considered it to be the cause of acidity, he called it " oxygen gas."

BLACK describes how nitre was obtained from " rich " soil

by " a particular set of people who make it their sole, or principal, business to travel from one part of the country to another in search of materials in which nitre is already produced."

Nitric acid and common salt or soda is mentioned as the only source of *cubic nitre* (species 4), sodium nitrate. *Digestive salt* (species 5), potassium chloride, was made by the action of potash on salt ammoniac. Under the heading of *common salt* (species 6), the preparation of hydrochloric acid is dealt with in considerable detail. *Vitriolic ammoniac* (species 7), ammonium sulphate, was also known as the " secret ammonia of GLAUBER." *Nitrous ammoniac*, or *nitrum flammans* (species 8), ammonium nitrate, is described by BLACK as being inflammable. The Editor states (I, 554) that BLACK, nineteen years before BERTHOLLET published his paper on the subject (*Mem. R. Acad. Sci.*, 1785, 319), prepared, collected and recorded the properties of nitrous oxide, using ammonium nitrate; BLACK stated that " the incondensible vapours " made a lighted paper burn with " prodigious violence " and had an effect on his breathing and sensations which was " far from being unpleasant."

Sal ammoniac (species 9) was obtained chiefly from soot, and was used for the preparation of ammonia. *Regenerated tartar* (species 10), potassium acetate, was so named because one of its component " salts " was the " salt of tartar " (or " vegetable fixed alkali ") and the other was one of the " vegetable acids "; BLACK, however, admits that " we now know perfectly well that the acetous acid which this salt contains is quite different from the acid of tartar." *Alkali fossile acetatum* (species 11), sodium acetate, was used for the preparation of concentrated acetic acid, by distilling it with sulphuric acid. *Acetous ammoniac*, *Spiritus Mindereri* (species 12), ammonium acetate, was, as it is now, used in medicine.

Tartar, *wine-stone*, *argal*, (species 13), potassium hydrogen tartrate, was a source of potash. BLACK states that, from his own experiments, he concluded that all native vegetable acids were tartaric acid, and that their different properties were due to non-saline ingredients. He was of the opinion that their various denominations (malic, citric, oxalic, etc.) had been multiplied without reason, because they were all " ultimately resoluble into acetous acid."

The alkaline properties of *borax* (species 14) were recognised, and rightly attributed to the weakness of the acid.

In BLACK's time there was considerable confusion in chemical nomenclature. Substances were named from the ingredients used in their preparation (e.g. " vitriolated tartar "), from what was thought to be their nature (e.g. " regenerated tartar "), from their physiological effects (e.g. " digestive salt "), from the discoverer (e.g. GLAUBER's salt), and from the place where first found (e.g. Epsom salt).

Volume I closes with 4 1/2 pages of synonyms for the substances already discussed; eleven synonyms are given each for ammonia and for sulphuric acid.

VOLUME II

(f) EARTHS (II, 1-202)

BLACK chooses the following distinguishing characteristics for the *earths* (class II) : they differ from the " salts " by want of solubility in water; they differ from combustible substances by their inflammable nature; they differ from the majority of metals on account of their low density; and, they generally exhibit a great degree of fixedness when heated. Having remarked that the substances which belong to this class compose almost the whole of the lithosphere, BLACK proceeds to review the field of geology (II, 5-20). He sub-divides this class into " alkaline earths " (those which effervesce with acids), " plastic earths " (clays), siliceous or flinty earths, fusible earths, " flexible earths " (e.g. mica, asbestos).

Alkaline earths (genus 1) are soluble in acids, which they neutralise, and with which they effervesce. *Calcareous earth* (species 1), calcium carbonate, is distinguished from other alkaline earths by the fact that heat converts it to quicklime. BLACK records that in converting the purest limestone to quicklime there is a loss in weight of 40 per cent. The heat generated during the slaking of quicklime, he attributes to latent heat. The action of lime on the alkalies, with the regeneration of chalk, is fully dealt with (II, 42-46). He gives an account of the theories which

preceded his own—the correct explanation—of the relationship of chalk and lime.

With *magnesia* (species 2), BLACK gives a full history of his researches, which closely follows his original paper, *Experiments upon Magnesia Alba, Quicklime and some other Alcaline Substances*, 1755 (*Alembic Club Reprints*, No. 1). He deals with the preparation and properties of magnesia, and describes his own experiments. These led to his explanation of the nature of lime : " I therefore considered the calcareous earth as a peculiar, acrid, soluble earth, appearing commonly under a mild and insoluble form on account of its union with fixed air : and I considered quicklime as the same earth deprived of its air " (II, 71). " Fixed air " (carbon dioxide) is mentioned here for the first time in the *Lectures*. BLACK goes on to say : " The sort of air with which the lime is disposed to unite, is a peculiar species, which is mixed in small quantity only with the air of the atmosphere. To this particular species I gave the name *fixed air*, the only term then used to denote any air that is condensed and fixed in different bodies, and is a part of their constituent principles." He then describes the series of experiments which he carried out to confirm this hypothesis. BLACK's claim to be the discoverer of carbon dioxide is clearly stated (II, 102).

He then proceeds to the subject of " pneumatic chemistry," which, he says, followed from the growing interest in gases shown at this period. PRIESTLEY is described as one of the most eminent devotees of this new chemistry. BLACK claims for his colleague, RUTHERFORD, the discovery of nitrogen, which the latter published in his inaugural dissertation (*De aere fixo dicto aut mephitico*, 1772).

Under the heading of *calcareous earths combined with acids*, BLACK treats of *gypsum*, *fluor*[*spar*] (including SCHEELE's work on " fluoric acid " and its use in etching), *phosphate of lime*, and *borate of lime*.

Barytes or *terra ponderosa* (species 3) and *strontites* (species 4) bring the section on " alkaline earths " to a conclusion. " Strontites " (strontium carbonate) was first found at Strontian, in Scotland.

The *plastic earths* (genus 2), says BLACK, all contain " argillaceous earth," i.e., china clay. He suggests that the earth separable

from alum should be called " argilla," rather than alumina, the name recently introduced by the French chemists.

Hard stony bodies (genus 3) all contain silica. Substances of this type, known to BLACK, are : rock crystal, chalcedony, quartz, agate, flint, jasper, carnelian, puddingstone, whinstone, silica limosa (found at the bottom of some Scottish lakes in mountainous districts). The manufacture of glass, the preparation of water-glass solution, and the precipitation of silicic acid are then dealt with.

The *fusible earths* (genus 4) are compounded from the six " earths " already mentioned and include : feldspar, porphyry, garnet, tourmaline, zoolite, and all volcanic rocks. The *flexible stones* (genus 5) with which BLACK deals are mica and asbestos. The remaining pages (II, 170-202) are occupied with appendices concerned with precious stones.

(g) COMBUSTIBLE SUBSTANCES (II, 203-388)

Inflammable substances (Class III) are introduced by further references to the phlogiston theory. BLACK offers excuses for SCHEELE's theory of heat and light, that they are due to the combination of oxygen and phlogiston, on the ground of the general acceptance of the theory at that time. At the same time, BLACK is critical of SCHEELE's omission to make use of the balance. He emphasizes that LAVOISIER's theory of combustion resulted from careful measurement : in every experiment, LAVOISIER found that the gain in weight on calcining an element equalled the weight lost by the air in which the operation was carried out. " Vital air," or oxygen, was assumed to be a compound of an " oxygenous principle " and " caloric." When combustion takes place the former combines with the substance oxidized, and the " caloric " is set free. The oxygen is a permanently elastic fluid only by virtue of the " caloric " it contains. As many substances yield acids with the " principle of vital air," LAVOISIER named it the " oxygenous " (acidifying) principle. BLACK's final remarks on the new theory (II, 215) leave little doubt of his preference for it to the phlogiston theory.

BLACK arranges the " inflammable substances " : " inflammable

air," phosphorus, sulphur, charcoal, " ardent spirits," oils, bitumens.

1. *Inflammable air* includes marsh-gas (" heavy inflammable air ") which is only distinguished from hydrogen by virtue of its density and brighter flame. BLACK was among the first to realise the use of hydrogen for balloons, which he suggests might be used, when anchored, for observation in war. BLACK states a case for PRIESTLEY's recognition as the discoverer of the composition of water (II, 233-4). The synthesis of water dealt the death blow to the phlogiston hypothesis : CAVENDISH and PRIESTLEY did not realize this, but LAVOISIER lost no time in appreciating its importance. BLACK and LAVOISIER believed that, as only dilute sulphuric acid yields hydrogen with iron, etc., the gas was obtained by the decomposition of the water. Hydrogen was considered to be the basis of hydrogen gas, which was a compound also containing caloric. From this BLACK goes on to discuss the nature of " volatile alkali," following the experimental work of BERTHOLLET and PRIESTLEY.

2. *Phosphorus*. BLACK, when giving examples of the highly inflammable nature of this substance, mentions matches, which he describes as " philosophical toys." The contributions of MARGRAAF, LAVOISIER and SCHEELE, to the investigation of the combustion of phosphorus, and phosphoric acid, are given. The nature of phosphine (described as " an inflammable gas, extremely foetid, smelling like rotten fish ") was not clearly understood by BLACK, who believed it to be a mixture of hydrogen and phosphorus vapour. Before SCHEELE and GAHN discovered that phosphorus could be obtained from bone-ash, it was extracted from urine.

3. *Sulphur* was considered by the phlogistonists to be a compound of sulphuric acid and phlogiston. LAVOISIER's investigations resulted in it being regarded as a simple substance—BLACK refrains from using the term element. The occurrence of sulphur in the animal and mineral kingdom is detailed, and its extraction from pyrites, and the impure mixture with earth, is explained. The manufacture of sulphuric acid was a secret process during BLACK's lifetime; from the information he gives, however, a form of the lead-chamber method was employed.

4. *Charcoal*. BLACK deals with its preparation and properties.

Among the latter he considers its adsorption of water, colouring matter and gases, although he did not know the true nature of this phenomenon. Carbon is defined as the common principle of charcoal, calcareous earths, and everything which contains or yields with oxygen, " fixed air." Evidence is given for considering the diamond as a pure form of carbon.

An appendix (II, 296-305) deals with " pyrophori " (substances which take fire on exposure to air) and " phosphori " (substances which glow in the dark after exposure to a strong light).

5. *Ardent spirits*, alcohol, after rectification usually had a s.g. of .82-.84, although BLACK himself obtained some with a s.g. of .80, by using " dried " calcium chloride. Because it leaves no residue, BOERHAAVE described it as the " pure pabulum of fire." BLACK claims (II, 320) to be the first to distinguish between nitrous and nitric acids, and to show that " GLAUBER's smoking spirit of nitre " was a mixture of the two. By adding alcohol to clear nitric acid he imparted to it all the properties of the liquid prepared by GLAUBER. " Nitric ether " and " muriatic ether " are considered along with " sulphuric ether." The action of nitric acid on sugar leads up to the subject of organic acids. BLACK remarks that " this department of chemical analysis is yet in its infancy."

6. *Oils* are described as being more complex than alcohol and less inflammable, yielding sooty matter during combustion. They are recognised as being compounds of mainly carbon and hydrogen. BLACK arranges them as " aromatic," " unctuous " and " empyreumatic " oils.

7. *Bitumens* comprise the " fossil inflammables " with the exception of sulphur. He deals with " fire-damp," naphtha, petroleum, bitumen proper, amber, and coal.

(h) METALS (II, 389-707)

Introducing *metals* (Class IV), BLACK stresses that research was retarded by the visionary projects of the alchemists. While dealing with the general properties of the metals, BLACK states that the least dense of those known is seven times as dense as water. He believed that the most malleable metals are liable to become more resilient by hammering. in consequence of the

expulsion of latent heat (II, 393). He compares the metals with the inflammable substances when considering their calcination. Among the then known reducing agents, BLACK mentions charcoal, oils, alcohol, hydrogen and " black flux "; the last, also known as " charcoal of tartar," was considered to be the best, owing to the alkali it contains rendering it fusible. The phlogistic explanation of calcination and reduction is introduced here; the difficulty of reconciling it with weight changes is brought forward as the telling criticism. BLACK's definition of an oxide is a compound containing oxygen " in less quantity than that which gives acidity."

When dealing with the action of metals and acids, BLACK recognises the principle of constant composition in compounds, and hints at the law of multiple proportions. The replacement of one metal by another in salts, and the use of metals in the manufacture of glass are referred to.

BLACK commences the study of metals with arsenic because it occurs so often in the ores of other metals.

1. *Arsenic* is recognised as not being a typical metal. The occurrence of arsenic, and its use in medicine, is followed by a consideration of arsenic poisoning, its detection and treatment. The tests described for arsenic do not compare favourably with those subsequently employed.

Under the heading " metallurgy," BLACK explains how ores are treated, and refers to AGRICOLA *(De Re Metallica*, 1556*)* for details of methods of washing and reducing. Assaying is described as an art employing *via sicca* (dry tests), but BLACK refers to *via humida* (wet tests) recently introduced by BERGMANN, FORDYCE and WOULFE.

2. *Magnesium* is the name used by BLACK for manganese dioxide. He refers to SCHEELE's pioneer work on this substance, as he does also in the case of arsenic. Chlorine (" oxymuriatic acid "), its preparation and properties, is introduced here.

3. *Iron*. The action of this metal with the mineral acids, the preparation of potassium ferricyanide, prussic acid, dyes and inks, and iron sulphate are dealt with in this section. It is recommended by BLACK as a medicine for a variety of complaints.

4. BLACK states that *mercury* has received much attention in the past on account of its medical and alchemical interest. The

preparation of *mercurius calcinatus* is described, and PRIESTLEY, SCHEELE and LAVOISIER are mentioned in connection with the generation of oxygen from it. Following the action of acids on mercury, BLACK deals with the oxides of nitrogen. The preparation and properties of corrosive sublimate and " mild sublimate " (mercurous chloride) are described at some length. Artificial cinnabar, mercury amalgam, the salts, oxides and the ores of the element are considered in this section. BLACK states that mercury was scarcer than gold.

5. *Antimony* is considered by BLACK as an imperfect, or " semi-metal," on account of its brittleness. Antimony was widely used in medicine, and BLACK devotes some 20 pages to its preparation.

6. *Zinc* or *spelter* is also classed as a " semi-metal."

7. *Bismuth* or *tinglass* is briefly treated.

8. *Cobalt* was best known for its use in colouring glass and enamels; its use for preparing sympathetic inks is described, but not explained.

9. In connection with *nickel* or *niccolum*, BLACK says of the work of BERGMANN : " The most highly refined niccolum that he was able to obtain by his great labour and skill was still attracted by the magnet, and had a very considerable degree of toughness or malleability. And he remained doubtful whether these qualities proceeded from iron still adhering to it, or are qualities belonging to this metal as well as to iron."

10. *Lead*. The peculiar properties of the metal, and the manufacture of shot are dealt with. Litharge, red lead (minium), the sulphate, nitrate, carbonate (white lead) and acetate, are considered. The discovery by DOLLAND of the value of flint glass for making achromatic lenses is mentioned.

11. *Tin*, *stannum*, is singled out as " the lightest of all the metals." The preparation of " Mosaic gold " is included. Tin is described as a cure for worms.

12. *Copper*. " Verdigrise " is stated to be " an acidulous oxyd or rust of copper." The combustion of copper and other metals with sulphur, in the absence of oxygen, led some chemists to question LAVOISIER'S theory of combustion. The preparation of various alloys containing copper, the ores, smelting and refinement of the metal are described.

13. *Silver*. The photochemical effect of light on silver salts

is described, but not explained. BLACK describes silver fulminate as " a loose compound of oxygen, silver, hydrogen and azote, having their double affinities so nearly balanced, that the slightest alteration of temperature, or even that position of [the] ingredients which produced the equilibrium of affinities, is enough to disturb this tottering equilibrium." The separation of silver from other metals, its occurrence, and further details of its cupellation complete the section.

14. *Gold*. In his treatment of this element, BLACK deals with gold alloys (including coinage which was 22 carat), methods of testing its purity (among which he describes the " touchstone "), its distribution and refinement .

15. *Platinum* was the densest metal known in BLACK's time. It was considered a likely metal for the debasement of gold.

BLACK's treatment of the metals concludes with platinum. ROBISON points out that he did not make any observations on molybdenum, tellurium, chromium, tungsten, uranium, and titanium, as, apparently, he did not consider that enough was known about them to justify their inclusion in his lectures (II, 762).

(i) WATER (II, 708-728)

The *Lectures* terminate with a fifth class, dealing with various types of *water*. These include rain water, fountain and well water, river water, water of lakes, marsh and shallow pool water, and sea water. BLACK's method of water analysis was to examine for carbonic acid, alkaline salts, sulphuric acid, muriatic acid, earths, sulphur, and metals. He describes how tests for these may be carried out.

(j) EDITOR'S NOTES. INDEX. PLATES (II, 729-762)

ROBISON's notes, generally, are very full, and often throw a useful light on contemporary thought, which had escaped BLACK's attention.

Not all copies of the *Lectures* are indexed. That in the possession of University College, London, has an index.

There are three plates. Plate I includes diagrams of thermometers, a " pulse glass " (cryophorus), and the steam engines

of the MARQUIS OF WORCESTER and JAMES WATT. Plate II contains illustrations of pieces of apparatus (retorts, crucibles, etc.), and Plate III, illustrations of several types of furnaces (including that shown on p. 378).

These volumes provide an interesting and useful study of a period of transition. BLACK introduces us to many of the modern chemical ideas, although the older doctrines of iatro-chemistry, phlogiston and caloric were accepted in his lifetime.

County School,
Epsom.

E. W. J. NEAVE.
January 1935.

Tombstone of V. V. PETROV.
Recently discovered in Smolenski Cemetery, Leningrad.

Vasilij Vladimirovič Petrov and his Physico-Chemical Work

Some time ago the Institute of the History of Science and Technology (Academy of Sciences, U.S.S.R.) in a public meeting commemorated the work of a physical chemist, of the academician and professor of applied physics, VASILIJ VLADIMIROVIČ PETROV. His activities are very little known even here and quite unknown abroad; but they are sufficiently valuable to warrant a short account of the man and of his investigations.

Born in 1761 in the town of Oboian (Government of Kursk) he received, being the son of a priest, his education in the theological college of Charkov and then in the higher Pedagogical Institute of St. Petersburg, completing the course in 1788. As a teacher of mathematics and physics he worked in Barnaul (Siberia) and after 1791 in several colleges of St. Petersburg. Having proved his worth as a teacher, he was elected in 1795 professor of mathematics and physics at the newly-established Medico-Surgical Academy of St. Petersburg. Here he got together the richest physical cabinet of his time in Russia, and here he made his chief investigations, which procured his admission to the Academy of Sciences, first as corresponding member (1802), then as full academician (1815). He continued his experimental work and devoted himself to meteorological observations until his death on July 22, 1834. Up to now we have been unable to find his portrait.

In order fully to appreciate his contributions to chemistry, we must say a few words on the state of that science about the year 1797 when V. V. PETROV began his investigations. Some ten years before that date LAVOISIER and certain other French scientists had brought about a revolution in chemistry : they substituted for immaterial chemical principles — material chemical elements, chemically undecomposable substances. This revolution, by the

way, was not brought to an end, as LAVOISIER, having completely renounced phlogiston *as a material* substance, still retained two unweighable, consequently immaterial, elements — caloric and light, which presented an unmistakable likeness to the *principle phlogiston*, as conceived by STAHL. These two elements are placed at the head of his list of elements of the year 1789. The new doctrine rapidly gained ground during the last years of the eighteenth century, the number of phogistians dwindling, that of the antiphlogistians increasing correspondingly.

At the beginning of his scientific career V. V. PETROV was obliged to make his choice between the two points of view; being a conscientious, modest man he resolved to look as closely as possible into the *facts* advanced by the French chemists. Studying their original work and thoroughly reasoning it out, he says that he came to some paradoxes — " viz., that the most learned of contemporary physicists failed to make as accurately as possible some very important experiments, the results of which would either wholly confirm the new doctrine, or urge the unprejudiced exponents of experimental physics to alter it. ... Thus endless scientific disputes between Antiphlogistians and obstinate Phlogistians would cease or rather diminish. ... Namely, I did not happen to read that anybody thought *expressly* of making, and actually accomplished, the following investigations :

" 1) Can natural combustible bodies burn in an airless place ?

" 2) Can metallic calces be formed in an airless place or not ?

" 3) Can perfect acids, resulting from the oxidation of simple bodies, be obtained in an airless place or not ?

" 4) If products can be obtained in the preceding cases in an airless place, will they be heavier than the materials used in the experiments ? "

V. V. PETROV resolved to make these experiments himself, and a favorable opportunity occured in 1797 when the physical cabinet of the Medico-Surgical Academy received from London a very important consignment of physical apparatus. He spent several years in the prosecution of these researches and published the results in three books and a number of papers between 1801 and 1812. The " Collection of New Physico-Chemical Experiments and Observations " of 1801 contains in its 553 pages a very detailed account of the experimental investigation of the

four fundamental questions just mentioned. In the preface, occupying another 35 pages, he gives an account of how he came to make the experiments, and concludes as follows:

"Being a Russian born, who has had no occasion of profiting by the instruction of foreign professors of physics, and up to now quite unknown to contemporary cultivators of that science ... I held it to be my duty to repeat several times with the utmost accuracy all my experiments and observations. ... I am indeed conscious of many deficiencies of style, expression, and beauty of language; but I felt myself quite unable to undertake the necessary revision in the sorrowful hours during which my soul found no consolation in philosophy, even in the Christian faith itself, after the death of my highly virtuous and dearest wife. These hours occur the oftener as I am left here without kin with three orphaned daughters. ... I hope that the defects of this book will not be viewed severely, at least by those readers who have a tender heart or have themselves experienced a similar misfortune."

The first experiments made in order to obtain an answer to question n° 1 were undertaken with such substances as wood, cotton, paper, and linen. These were placed in a closed glass jar, the air pumped out, and the substance ignited by means of a burning glass (Fig. 1). The result in every case was that the

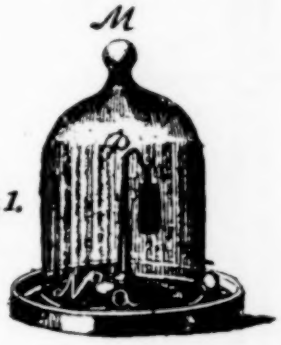
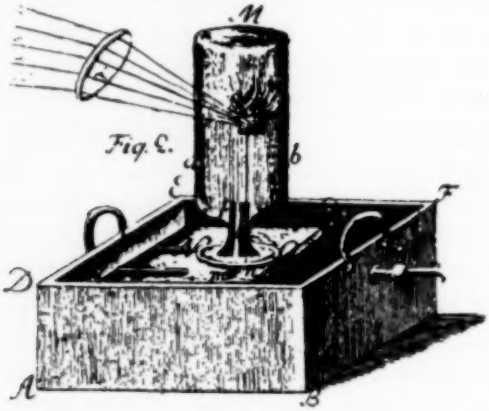


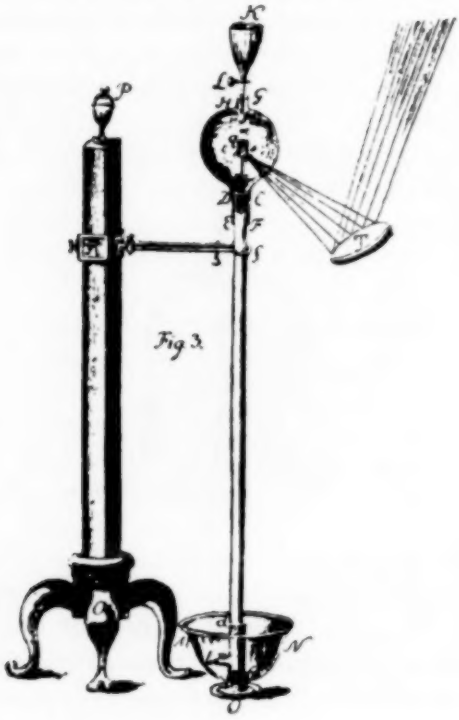
Fig. 1.

substance began to burn, emitting smoke but no flame. Thinking that this might be occasioned by air left in the pores of the combustible, or in the glass jar, V. V. PETROV measured with great care the quantity of pure oxygen necessary to burn an equal quantity of wood, cotton, etc., in a cylinder placed in a pneumatic

trough (Fig. 2). This quantity exceeded by thousands of times the amount of oxygen left in the wood or in the jar. Dry wood,



especially cut into fine slabs, burned also in a perfect Torricellian vacuum, obtained in the apparatus of Fig. 3. The globe, *HDEFCG*,



placed on the top of a tube 32 inches long, was repeatedly filled with mercury through *K* and the excess then let out through the tube *m*, until the mercury in the tube had the same height as in a barometer. This combustion of natural bodies in a vacuum V. V. PETROV explained by the fact that all these substances contain oxygen, as shown by LAVOISIER ; thus the observational facts do not invalidate his doctine, but support it.

Further experiments made with " sulfuric and acetic naphtas " (ethyl ether and acetic ester), with turpentine, etc., which burn very readily in the air, showed that they do not burn in a vacuum, but only volatilize. PETROV says in concluding these observations : " I hope that enlightened and unprejudiced Physicists will at least some day consent to render me the justice due to the significance of these experiments."

Questions n° 2 and 3 were investigated by means of many experiments conducted with phosphorus, sulfur, and potassium. The glowing of phosphorus in the air is an indication of slow oxidation. PETROV found that it begins to manifest itself only at a temperature between + 7° and + 8° R; phosphorus catches fire in the air at + 32° R. In the imperfect vacuum of the air pump phosphorus burns for some seconds when heated by the sun's rays; but in the perfect vacuum of TORRICELLI phosphorus neither burns nor glows on being heated. The same is true for sulfur. Neither substance forms acids (as their oxides were then called) in a perfect vacuum, as PETROV ascertained by the introduction of moistened litmus paper.

Work with potassium was begun in 1808 (H. DAVY obtained it in October of 1807) and prosecuted during several years to settle the question : will potassium give out flames or sparks during the decomposition of water in the total absence of oxygen? Many experiments were made with water previously boiled, with the air expelled by the air pump, and by covering boiled water with a thick layer of mountain oil. Naturally some of these experiments were accompanied by explosions, by which PETROV was seriously wounded. But he did not leave his work and brought it to completion, having conclusively demonstrated that oxygen gas was necessary for burning potassium on the surface of water. As a true follower of LAVOISIER, he accepted the theory that oxygen

gas was composed of oxygen substance, caloric, and light — the last two being set free during oxidation.

Another series of experiments dealt with the combustion of metals in a vacuum. Small quantities of calces (oxides) were obtained with tin and lead in a vacuum produced by the air pump, apparently resulting from the small quantity of air which was left in the jar.

Some experiments deal with a question added to the four original ones given above : can natural bodies burn in gases which immediately extinguish burning bodies? Eight such gases (hydrogen, nitrogen, ammonia, hydrogen chloride, carbon dioxide, etc.) were prepared pure and experimented with in the apparatus of Fig. 4; as combustible substance wood was used throughout.

Fig. 4.

The results were identical with those obtained in a vacuum : the wood burned owing to its oxygen content.

Almost all these results, completely vindicating the new doctrine, were obtained during the years preceding 1801, as they are contained in his book of that date, and PETROV became a fully-convinced Antiphlogistian. If his painstaking investigations had been published abroad, they would surely have contributed to the

spread of the oxygen theory. As it was, they exercised an enormous influence only on the early Russian chemists, who were all Antiphlogistians. PETROV took the straightest road to ensure the triumph of the new chemistry — the road of experiment and practical demonstration.

I have given a short summary of the chief investigations of our physical chemist. A few concluding remarks must be made about his other work, of which I will mention but two items. The glow of phosphorus in the dark was naturally succeeded by an examination of the glow of decaying wood, meat, fish, etc. Many experiments made in this direction established that this glow was dependent on oxygen and consequently was to be regarded as some sort of slow oxidation. It was quite otherwise with the phosphorescence of mineral products — of differently colored specimens of fluorspar, of Kanton phosphorus (obtained by melting together two parts of limestone and one part of sulfur). PETROV found that this phosphorescence was quite independent of oxygen, being the same in the air and in a vacuum, or in water, at high and at low temperatures. He further obtained evidence that phosphorescence is a property of almost every solid under suitable conditions. No explanation of phosphorescence was offered.

The other point which I must touch upon is PETROV's work on electricity, described in two monographs issued in 1803 and 1804. The first contains a description of the " immense battery " employed — a voltaic pile built early in 1802 out of 4200 triplets, each triplet consisting of three discs, a copper, a zinc, and a paper one moistened with a solution of ammonium chloride. Assembled this pile had a total lenght of over forty feet, distributed into four rows. Many were the experiments made with this pile ; two of them are especially interesting.

a) V. V. PETROV connected two pieces of charcoal by means of metal wires with the two poles of his " immense battery ", laid them on a sheet of glass and on bringing them together obtained an intense white flame " which ligthed a whole room ". This is the first mention of an electric arc : H. DAVY described it several years later. Similar flames were produced in like conditions between charcoal and thin pieces of metals.

b) On heating a mixture of metal oxide and powdered charcoal

or tallow by the " fluid of the immense battery ", metal was formed. So far as I know, this is the first known experimental electrosmelting.

All the papers of V. V. PETROV were printed only in Russian and his extremely careful and exact work is, as stated, quite unknown abroad. No mention of his name is found in any history of chemistry. In spite of this he is the man who put the finishing touches to the new chemistry by experimentally removing the " paradoxes " incompatible with it.

BORIS N. MENSCHUTKIN.

Leningrad, U.S.S.R.

On a curious subdivision of the Egyptian cubit

There are many publications on the Egyptian cubit but most of them are naturally devoted to the determination of its length and its possible relationships with other standards of the ancient world. It may interest historians of science to know that the first investigation of that subject was made by no less a person than ISAAC NEWTON, but his paper was only published in 1737, ten years after his death, being entitled " A dissertation upon the sacred cubit of the Jews and the cubits of the several nations; in which from the dimensions of the greatest Egyptian pyramid, as taken by Mr. JOHN GREAVES, the ancient cubit of Memphis is determined," in JOHN GREAVES (1602-52) : Miscellaneous works (vol. 2, 405-33, London 1737). This was written by NEWTON in Latin, probably toward the end of his life, when his old interest in theology and Biblical archaeology was engrossing his mind more and more. According to ARCHIBALD's elaborate bibliography of Egyptian mathematics (1927-29), NEWTON's paper was the first but one to deal with the mathematical side of Egyptian archaeology (1). NEWTON's study is remarkable in another way. In spite of the fact that his argument was based upon three wrong premises, he found a length of the royal cubit which was incredibly close to the correct one ! (2)

During a recent visit to the Metropolitan Museum of New York I noticed two fragments of Egyptian cubits :

(1) First two digits of a royal cubit. Flint-like limestone, New Kingdom, i.e., XVIIIth to XXth Dynasties (1580-1090 B.C.).

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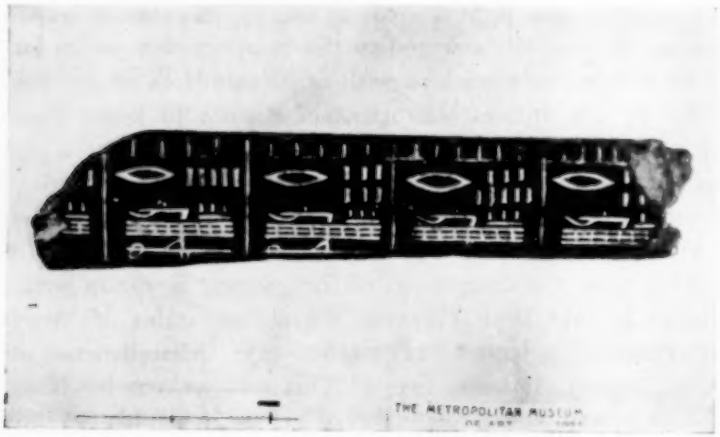
(1) His only predecessor was the Dane HANS GRAM (1685-1748), author of *De origine geometriae apud Aegyptios* (Copenhagen 1706).

(2) After LUDWIG BORCHARDT : *Gegen die Zahlenmystik an der grossen Pyramide bei Gise* (40 p., Berlin 1922, see p. 36). NEWTON's value is equivalent to 527.9 mm.; the real length is about 523 mm. (= 20.6 inches) to 525 mm.

The first digit inscribed one half, the second one third (Lent by W. GEDNEY BEATTY 1918).

(2) Fragment of about four digits, including three complete ones. Green slate. Dimensions : length, 8 cm., width 4 cm., thickness 1.5 cm. New Kingdom. Accession number : M. M. A. 25.7.41 (Presented to the Metropolitan by Dr. and Mrs. THOMAS H. FOULDS in 1925). Thanks to the courtesy of the Metropolitan Museum we are able to reproduce this second fragment.



The character in the shape of a lens (really a mouth) desginates a fraction; it is phonetically equivalent to the Hebrew letter resh(r), and may be pronounced *er ;* I will write it that way. *Er* accompanied with five vertical strokes means fifth, accompanied with six strokes it means, sixth, etc. In the example illustrated we see the fourth, fifth and sixth digits, respectively divided into fifths, sixths and sevenths (see the actual divisions at the top of our illustration).

According to other examples described by LEPSIUS (1866) and SCHIAPARELLI (1927), the royal Egyptian cubits were divided into seven palms of four digits each, but the fact upon which I wish to draw attention is the very curious subdivision of the digits.

The first (beginning from the right) is divided into two parts, the second into three, and so on, until the fifteenth which is divided

(3) WALLIS BUDGE : *Egyptian dictionnary* (415, London, 1920). ALLAN H. GARDINER : *Egyptian grammar* (196, 444, Oxford, 1927).

into sixteen. There is one example mentioned by LEPSIUS (his no. 5, p. 15, 28), wherein the sixteenth digit was divided into seventeenths, but this seems to have been the result of a mistake. In other examples, the thirteen remaining digits are not subdivided. It should be noted that as the length of a digit is less than 2 cm., subdivision into sixteen parts reaches almost the practical limit of visibility.

What may have been the purpose of that strange subdivision? Why was it necessary to have ready scales in fractions of a digit—from the half to the sixteenth? This was probably connected with the Egyptian exclusive interest in fractions of the type $1/n$ (4). Their rulers made it possible to determine the actual length indicated by such an expression as one cubit plus one fifth, one eighth and one fourteenth, yet the same purpose might have been attained in a simpler manner.

The use of such rulers for the graphical solutions of arithmetical problems cannot be countenanced, for the divisions were not precise enough. Indeed as LEPSIUS remarked (1866, 18) the subdivisions of the cubit are sometimes unequal and the digits have not all the same length. In the schematic example on his plate 1, the first sixteen digits are 18.75 mm. long, the eight following (17th to 24th), 17.19 mm. long, the last four, 21.87 mm. long. Indeed various characteristics of the cubits preserved in our museums suggest that they were objects meant for ceremonial rather than practical use. For example, in the beautiful cubit of the museum of Torino, each digit is associated with a god whose name is written above it (5). Moreover various cubits

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(4) They expressed all other fractions except 2/3 in sums of fractions of that type.

(5) Remarks SCHIAPARELLI (1927, p. 172): "Oltrechè per la richezza della materia e per la finezza del lavoro, principalmente per le iscrizioni che vi sono impresse, questo cubito non può adunque considerarsi come un oggetto di carattere e di uso privato, ma è evidentemente un ogetto commemorativo, un vero monumento, di pertinenza del Faraone e preparato per esso: e se il medesimo si sia trovato nella tomba di CHA, è a ritenere che a lui sia donato da AMENOFI II Stesso." The king may have presented a "cubit of honor" to his architect, in the same spirit as a "sword of honor" is given to a soldier. It is interesting to note that the same tomb contained also a wooden cubit folding in two parts around a hinge, just like our folding two foot rulers, together with a leather purse to keep it in, this being probably the very instrument which CHA carried with him (FIGS. 46, 47).

being made of stone were too heavy and fragile for convenience.

The subdivision of the digits into a number of parts increasing one by one from two to sixteen, was thus more probably of theoretical than of practical importance. Some of their arithmetical problems, whether published or unpublished, may possibly throw light on this mystery.

Harvard Library, 185. GEORGE SARTON.
Dec. 27, 1935.

BIBLIOGRAPHY

KARL RICHARD LEPSIUS (1810-84): Die altägyptische Elle und ihre Eintheilung (*Philol. Abhandl. der Akademie der Wissenschaften zu Berlin*, 67 p., 5 pl. Berlin 1866). Read at the Academy in February 1865. It contains five excellent schematic plates.

ERNESTO SCHIAPARELLI (1856-1928): La tomba intatta dell'architetto CHA nella necropoli di Tebe (Torino 1927). Includes a description (p. 168-73) and photographs (figs. 155, 156) of the splendid golden cubit of the XVIIIth dynasty (AMENOPHIS II, 1448-1420) found in that tomb and now in the museum of Torino.

I beg to thank the Metropolitan Museum for its kindness in sending me the photograph used in this note, and Mr. DOWS DUNHAM of the Boston Museum of Fine Arts for his friendly guidance. Courtesies received from Dr. H. E. WINLOCK, Curator of the Egyptian Department and Director of the Metropolitan, Prof. JEAN CAPART, Director of the Musées du Cinquantenaire in Brussels, Dr. SIDNEY SMITH, Curator of the Egyptian Department of the British Museum, Sir FLINDERS PETRIE, Jerusalem, and Dr. C. T. CURRELLY, Director of the Toronto Museum, are gratefully acknowledged. G. S.

Egyptian water clocks

ABSTRACT

Reconstruction of a prismatic prototype of cylindrical inflow clocks. Operating with the simplest fractions, 1/2 and 1/3, and drawing straight lines only, we may construct a prismatic diagram which accounts for the unusual features of the cylindrical diagram of the Edfu inflow clock. The new diagram points to an Egyptian—not Greek— origin of several passages of classical literature dealing with the rate of increase of the length of the day.

Reproduction and discussion of hitherto unpublished items connected with water clocks, such as the prismatic model in the Metropolitan Museum (Acc. No. 86.1.93) and the Medinet Habu astronomical ceiling. It is shown that the decanologue of the Karnak outflow clock is closer related to the Senmut decanologue than to those of the Ramesseum and of Medinet Habu.

1. *Introduction.*

A detailed treatment of Egyptian methods for measuring time—by the flow of water or the apparent motions of the sun and of the stars—will be found in L. BORCHARDT's (1) monumental Altägyptische Zeitmessung; a good survey of the more important problems is given in R. W. SLOLEY's (2) papers on the same subject. The present paper will be devoted to some of the neglected aspects of the problems presented by Egyptian water clocks.

2. *Kircher.*

" The theories of KIRCHER as to the content of the hieroglyphic inscriptions exceed all bounds in their imaginative folly " (3);

(1) Die Geschichte der Zeitmessung und der Uhren, hrsg. von E. v. BASSERMANN-JORDAN. Bd. I, Lieferung B : LUDWIG BORCHARDT, Die Altägyptische Zeitmessung. Berlin, 1920.

(2) Ancient clepsydrae. *Ancient Egypt*, 43-50. London, 1924. Primitive methods of measuring time, with special reference to Egypt. *The Journal of Egyptian Archaeology*, 17, 166-78. London, 1931.

(3) ALAN H. GARDINER, Egyptian Grammar, p. 11. Oxford, 1927.

this harsh statement is, unfortunately, fully justified; occasionally, however, the vivid imagination of ATHANASIUS KIRCHER (1601-1680) could lead to scientific discoveries. When a fragment of a granite vase was excavated, in Rome, near Santa Maria sopra Minerva, he thus described (4) this valuable addition to the growing Museum Kircherianum :

" Hoc eodem loco erutum fuit vasis Nilotici fragmentum hieroglyphicis notis refertum, ex quo apertè Niloticorum vasorum ratio & forma dignoscitur. Videtur illic linea in duodecim partes distributa, in qua per interiorem vasis superficiem, vsque in fundum, duodecim ordine aequaliter inter se distantes veluti termini quidam eminentes disponuntur; qui termini haud dubiè vel ad incrementum decrementumque fluminis, vel ad horas in hydrologio commonstrandas, deputabantur. In exteriori verò vasis superficie, ad extremum vasis limbum, circulus est in 365 stellas diuisus..."

Although KIRCHER's fragment contained but two incomplete monthly scales, he arrived at the conclusion that a complete scale must consist of 12 parts; one of the two fragments in the Museum Gaddianum, in Florence, contained a complete scale, which may account for KIRCHER's generalization. On p. 385 of Oedipus Aegyptiacus is reproduced a plate borrowed from GIOVANNI NARDI's edition of LUCRETIUS (Florence 1647); see facsimile of pp. 384 and 385 of Oedipus in *Isis*, 24, 431, 1936. KIRCHER, not NARDI, deserves full credit for the interpretation of the two fragments from the Museum Gaddianum. To appreciate the value of KIRCHER's hypothesis—that the " Nilotic vases " were either Nilometers or " hydrologia," i.e., water clocks,—it is necessary to compare it with the status of the clepsydra problem in the beginning of the present century. Incidentally, it is a curious coincidence—which does not excuse KIRCHER's " imaginative folly " where hieroglyphic inscriptions were concerned—that his " Nilotic vase," found near Santa Maria sopra Minerva, originally came from a temple of the Nile-god.

3. *From Kircher to the Karnak clepsydra.*

In the beginning of the present century, little was known

(4) A. KIRCHER, Oedipus Aegyptiacus, v. 3, p. 384. Rome, 1654 (colophon : 1655).

about Egyptian water clocks, despite literary references and the presence of more than a dozen fragments in European museums. Thus, in 1901, A. WIEDEMANN (5) published a paper containing a description of fragments of six water clocks; here are his conclusions (6) :

" There must exist a connection between these vessels and the months of the year, as is shown by the month divinities they bear, and by the number 12 playing a *rôle* in the point-lines engraved in their inside. Perhaps the purification-water in them stood under the protection of the cycle of these divinities. The gods named in the dedication formulas may have been the gods out of the temples of which the vessels originally came. But, in all cases, I believe, we have to see in them the type of the purification-vessels, of which Heron (7) speaks in the passage quoted at the beginning of this communication."

In 1901, G. MASPERO found, in Edfu, a water clock of the inflow type; this specimen, of the Roman period (ca. A.D. 100), is now in Cairo, and seems to be the only inflow clock extant. A description of the Edfu water clock was published by G. DARESSY (8) in 1902; he considered (9) the " grand vase en pierre avec graduations " as belonging to the " catégorie des vases récemment étudiés par M. WIEDEMANN comme ayant servi aux purifications," not as a water clock. Long after it was recognized as an inflow clock, Sir FLINDERS PETRIE (10) wrote, in 1924 :

" Regarding the Edfu cylinder, it is very difficult to regard it as an inflow vessel, because the lines start from a uniform level at the top, and vary greatly between the months below. The idea of beginning each night by a variable filling up to a given mark seems very unlikely. There is one way in which it would work truly as an outflow vessel like the Karnak vessel..."

In 1903, the Oxyrhynchus (11) papyrus fragment 470 was published; it deals, in lines 31 to 87, " with the construction of a *ὡρολόγιον* or time-piece, shaped something like a flower-pot " (12); in his interpretation of this papyrus fragment of the

(5) Bronze circles and purification vessels in Egyptian temples. *Proceedings Soc. Biblical Archaeol.*, 23, 263-74. London, 1901.

(6) *Loc. cit.*, p. 274.

(7) Pneumatica, II, 32, p. 148, ed. SCHMIDT.

(8) Grand vase en pierre avec graduations. *Annales du service des antiquités de l'Égypte*, 3, 236-39. Cairo, 1902.

(9) *Loc. cit.*, p. 236.

(10) *Ancient Egypt*, p. 50. London, 1924.

(11) The Oxyrhynchus papyri, Part III. Ed. by B. P. GRENFELL and A. S. HUNT. London, 1903.

(12) *Loc. cit.*, p. 142.

third century of our era, J. G. SMYLY (13) uses the following cautious expression (14) : " if the instrument in question were a water clock, a knowledge of this volume would be of great importance "; apparently, he failed to study the dimensions and the water-level scales of the fragments of WIEDEMANN's " purification vessels." A complete analysis of lines 31 to 87 of the Oxyrhynchus fragment 470, with facsimile, emendated transcription, translation, computations, diagrams, etc., will be found in BORCHARDT (15). The " flower pot " discussed in the papyrus had an upper diameter of 24, a lower diameter of 12, and a height of 18 *δάκτυλοι* (fingerbreadths); the duodecimal graduation was limited to the upper two-thirds of the vessel.

The problem of Egyptian water clocks appeared in a new light, in 1904, when G. LEGRAIN discovered, in Karnak, the magnificent translucent alabaster outflow clock which is now in Cairo; it has an upper diameter of 24, a lower diameter of 12, and a height of 18 Egyptian fingerbreadths (16); the duodecimal graduation covers the upper two-thirds of the vessel. The Karnak clepsydra was made about 1400 B.C., during the reign of AMENHOTEP III (XVIIIth dynasty); it is, therefore, more than a thousand years older than the oldest known fragments of an outflow clock (ca. 330 B.C.; BORCHARDT's Auslaufuhr 2).

G. DARESSY's (17) paper on the two clepsydrae in Cairo—the Edfu inflow clock and the Karnak outflow clock—appeared in 1916. KIRCHER's hypothesis that the three fragments known to him were parts of " hydrologia," water clocks, became an obvious fact—but KIRCHER did not get credit for his vision.

The following tabulation will help the reader to see the development of Egyptian chronometry and calendariography in the right perspective.

(13) *Ibid.*, p. 141 : " For the interpretation of this papyrus we are indebted to Mr. J. G. SMYLY."

(14) *Ibid.*, p. 145.

(15) Altägyptische Zeitmessung, p. 10 ss.

(16) An Egyptian fingerbreadth is 18.75 mm., about 3/4 in.

(17) Deux clepsydres antiques. *Bulletin de l'Institut égyptien*, 5e série, 9, 5-16, 1915. Cairo, 1916.

TABLE 1

Calendars, water clocks, and ceiling decorations

Item	Year (approx.)	Dynasty
Asyut calendars	2000	IX-XI
AMENEMHET's clepsydra	1550	XVIII
SENMUT's ceiling	1500	XVIII
Karnak clepsydra	1400	XVIII
SETI's ceiling	1350	XIX
Ramesseum ceiling	1250	XIX
Medinet Habu ceiling	1175	XX
ALEXANDER's clepsydra	330	
Edfu clepsydra	A.D. 100	
Oxyrhynchus papyrus 470	250	

4. *Prismatic inflow clocks.*

No satisfactory explanation has been given for the distribution of the vertical lines engraved in the cylindrical inflow clock from Edfu. The distances of these lines vary as follows :

3:2:1; 1:2:3; 3:2:1; 1:2:3,

if one begins with the longest scale of 14 fingerbreadths or with the shortest scale of 12 fingerbreadths ; see Figure 2.

The ratio 14:12 for the lengths of the scales corresponding to the longest and to the shortest nights, respectively, did not change from the time of AMENEMHET until the end of Egyptian history; this implies, of course, that the length of the scales corresponding to the equinoxes should be 13. The maker of the Karnak outflow clock probably followed AMENEMHET in making the further simple assumption that the lengths of the scales between 12 and 13, 13 and 14, 14 and 13, and 13 and 12, vary uniformly, 1/3 of a fingerbreadth per month. The next step in the development of water clocks—made, apparently, by a designer of an inflow clock—was the correct observation that the length of the nights changes slowly during the month immediately preceding and during the month immediately following the shortest or the longest night; the advanced design of sun dials made such an observation possible at a relatively early date.

Here is a simple method for incorporating this observation

into the scales of a prismatic inflow clock with a square base; see Figure 1. The corner scales of the prism ADGJ are 14, 13, 12, and 13 fingerbreadths, respectively; each corner scale is divided into 12 equal parts, and the corresponding points are joined by inclined straight lines which form "stripes" on

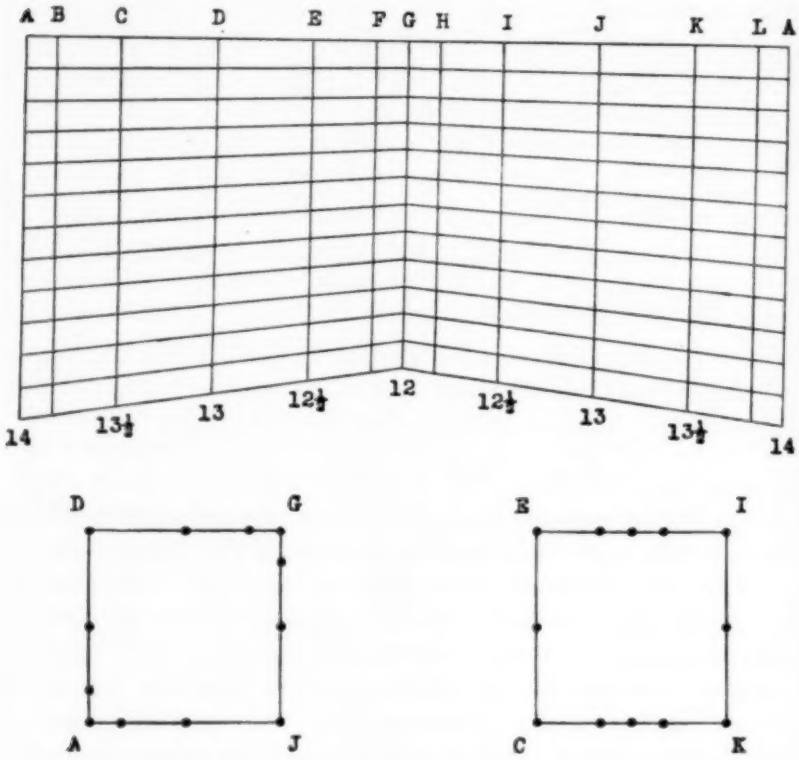

FIG. 1. — Graduation of the 1:2:3 type for a square prismatic inflow clock. Enlarged five times, the diagram would fit the Edfu clock.

all four walls; additional vertical lines are then drawn through the centers, C and K, and E and I, of the sides of the prism, and form the 13 1/2 and the 12 1/2 scales, respectively; finally, the distances AC and AK, and GE and GI, are divided into thirds, and the vertical lines B and L, and F and H, form the 13 5/6 and the 12 1/6 scales, respectively.

Here is another method for drawing the diagram of Figure 1

on the inside of a square inflow clock. The corner scales of the prism CEIK are 13 1/2, 12 1/2, 12 1/2, and 13 1/2 fingerbreadths, respectively; the equinoxial scales, D and J, occupy the middle of the side walls of the prism, while the solstitial scales, A and G, with their satellites B and L, and F and H, are drawn on the inside

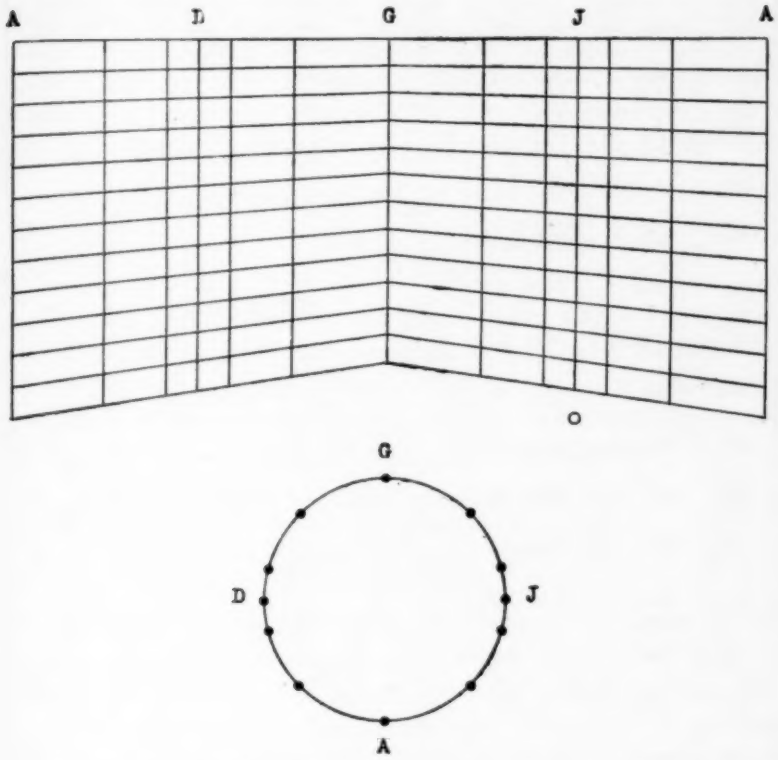

FIG. 2. — Graduation scheme of the cylindrical inflow clock from Edfu. One-fifth of the size of the original.

of the front and back walls, respectively; the inclined lines form " chevrons " on the front and back walls, and ordinary " stripes " on the side walls.

5. *Obsolescence of rim inscriptions.*

It is, practically, indifferent whether the scales of an outflow or of an inflow clock are assumed to be correct at the beginning

or in the middle of an Egyptian month of 30 days; the water clocks completely disregard the 5 epagomenal days, but even

TABLE II

The civil year and the seasons

Year B.C.	Civil New Year's Day	Vernal equinox	Vernal equinox	Summer solstice	Autumnal equinox	Winter solstice
1617	Oct. 1	Apr. 4	VII	X	I	IV
1497	Sep. 1	Apr. 3	VIII	XI	II	V
1373	Aug. 1	Apr. 2	IX	XII	III	VI
1249	July 1	Apr. 1	X	I	IV	VII
1129	June 1	Mar. 31	XI	II	V	VIII
1105	May 1	Mar. 30	XII	III	VI	IX
885	Apr. 1	Mar. 29	I	IV	VII	X
761	Mar. 1	Mar. 28	II	V	VIII	XI
648	Feb. 1	Mar. 28	III	VI	IX	XII
524	Jan. 1	Mar. 27	IV	VII	X	I
401	Dec. 1	Mar. 25	V	VIII	XI	II
281	Nov. 1	Mar. 25	VI	IX	XII	III
157	Oct. 1	Mar. 24	VII	X	I	IV
37	Sep. 1	Mar. 23				

Note.—Roman numerals refer to Egyptian months.

The first two columns show the rapid recession, through the Julian calendar, of the civil New Year's Day, i.e., of the 1st day of the 1st month of the *3ḫt* season, or, in the post-Persian period, of the 1st day of the month Thōuth.

The first and third columns show the slow recession, through the Julian calendar, of the date of the vernal equinox.

The last four columns indicate, roughly, the Egyptian months of the equinoxes and solstices. Thus, during the fifteenth century, the civil year began in August, and the winter solstice fell on dates advancing through the 1st month of the *prt* season; in the fourth century, the civil year began in November, and the winter solstice progressed through the month Phaōphi.

this is of little importance; what matters, in the long run, is the neglected difference of about 1/4 of a day between the length of the tropical or of the stellar year, on the one hand, and the length of the civil year of 365 days, on the other. This difference amounts to one day in four years, or one month in about 120 years; in the course of centuries, the names of the months marked on the upper rim of a water clock cease to correspond to the scales which are engraved immediately below them; see Table II. Let us take the case of a prismatic inflow clock, ADGJ or CEIK, which was "correct," according to Egyptian standards, about 700 B.C.; the twelve months are so distributed over the rim that

XI (3rd m. of *ḫmw*) appears over the winter-solstice scale A;
II (2nd m. of *ꜣḫt*) „ „ „ vernal-equinox „ D;
V (1st m. of *prt*) „ „ „ summer-solstice „ G;
VIII (4th m. of *prt*) „ „ „ autumnal-equinox „ J.

After the lapse of about 120 years, there was a discrepancy of one month between the names on the rim and the scales of the clock. By the middle of the fifth century B.C., the discrepancy amounted to two months. At the time of ALEXANDER the Great, the readings on our clock had to be made as follows :

during II (Phaōphi), on the winter-solstice scale A;
„ V (Tybi), „ „ vernal-equinox „ D;
„ VIII (Pharmouthi) „ „ summer-solstice „ G;
„ XI (Epiphi) „ „ autumnal-equinox „ J.

The simple process of erasing and shifting the names of the months on the rim, in order to keep an old water clock "up-to-date" was actually used, as some of the preserved fragments of outflow clocks reveal. In most cases, however, the reading was simply done, during the lifetime of a generation, on scales removed, say, two or three or five months, from the names engraved on the rim. When a new clock was made, correct names would be engraved on the rim, over the scales; the maker of the new clock would, of course, preserve the arrangement of the scales on the walls of the prism, but would engrave the correct name of the month with the shortest night over the shortest scale, and shift the other names correspondingly.

6. *The Edfu diagram.*

When prismatic inflow clocks were replaced by cylindrical ones,

the diagram remained unchanged, and the distances between the scales,

1:2:3; 3:2:1; 1:2:3; 3:2:1,

preserved on the cylindrical diagram of the Edfu clock, point, it seems to me, clearly to the prismatic prototypes of the cylindrical inflow clocks. The Edfu diagram, Figure 2, is a somewhat careless and not too intelligent copy of a diagram of the type reproduced in Figure 1; it was copied either directly from an obsolete prismatic inflow clock, or, more likely, from a cylindrical inflow clock which was " out-of-date." The fact that the Edfu diagram begins the 1:2:3 count from the autumnal-equinox scale placed over the cynocephalos orifice seems to indicate that the maker of the clock was trying to copy a diagram which originated on the inside of a prismatic clock of the " chevron " type, CEIK, where the cynocephalos orifice was placed, for reasons of symmetry, below a solstitial scale; the engraver of the Edfu diagram did not realize that the 1:2:3 count of distances between the scales must begin at a solstitial scale, and that the position of the cynocephalos orifice is irrelevant; he saw that the diagram he was trying to copy started the 1:2:3 count from the orifice, and he faithfully reproduced this irrelevant detail. The lengths of the Edfu scales increase and decrease by the traditional amounts, 1/12, 1/6, and 1/4 of the difference between the longest and the shortest night, but the wrong starting point of the 1:2:3 count leads to slow changes of the lengths of the scales near the equinoxes, and to rapid changes near the solstices—an absurdity which failed to shock the maker of the Edfu clock; apparently, like many an Asyut coffin decorator who did not understand the meaning of the calendar table he was copying, this clock maker of the Roman period did not understand the meaning of the 1:2:3 diagram.

7. *Cleomedes' duodecimal rule.*

Our prismatic diagram reproduced in Figure 1 accounts not only for the cylindrical diagram of the Edfu clock—it throws new light on several passages of classical literature (18) dealing

(18) CLEOMEDES, *Κυκλικὴ θεωρία μετεώρων*, I, 6. The text of CLEOMEDES is unusually clear and well preserved. Other references may be found in G. BILFINGER, Die antiken Stundenangaben, p. 153, Stuttgart, 1888.

with the seasonal rate of increase and decrease of the length of the day and of the night. CLEOMEDES (19), who lived, in all probability, in the first century B.C., states that the difference between the longest and the shortest day is thus distributed on the six months which follow the winter solstice :

during	the	1st	month,	the	day	increases	by	1/12	of	the	difference;
during	,,	2nd	,,	,,	,,	,,	,,	1/6	,,	,,	difference;
during	,,	3rd	,,	,,	,,	,,	,,	1/4	,,	,,	difference;
during	,,	4th	,,	,,	,,	,,	,,	1/4	,,	,,	difference;
during	,,	5th	,,	,,	,,	,,	,,	1/6	,,	,,	difference;
during	,,	6th	,,	,,	,,	,,	,,	1/12	,,	,,	difference.

The numerators of these fractions immediately suggest an Egyptian origin of CLEOMEDES' rule. A glance at our diagrams

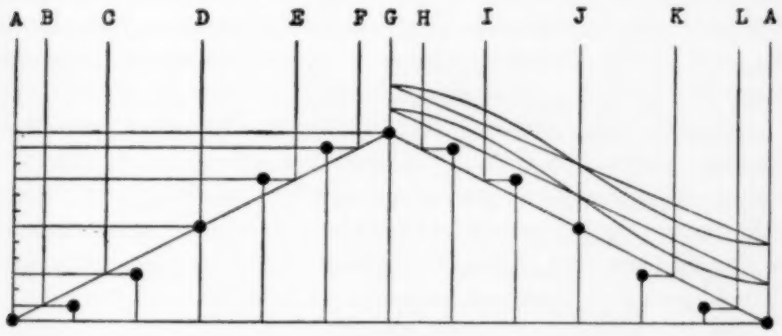

FIG. 3. — CLEOMEDES' duodecimal rule and the prismatic diagrams of the 1:2:3 type.

reproduced in Figures 1 and 3 shows that these six fractions are the direct result of the 1:2:3 process of distributing the twelve monthly scales on the four inside walls of a square inflow clock; it was the intention of the Egyptian inventor of the 1:2:3 diagram to produce scales showing slower monthly variations near the solstices and faster ones near the equinoxes; the monthly rates, 1/12, 1/6, and 1/4, happen to be an inevitable consequence, for the ordinates of the diagram, of a simple and symmetrical geometrical construction based on the favorite Egyptian fractions, 1/2 and 1/3, applied to the abscissae.

The numerical example given by CLEOMEDES is, obviously,

(19) *Loc. cit.*, I, 6.

of his own making, and throws no light on the country of origin of his duodecimal rule; he uses the simplest possible fraction, 1/2 hour, for the smallest monthly increase, and, therefore, 6 hours for the total difference between the longest and the shortest day —a difference which exists under latitude 41° or 42°, if we count the days from sunrise to sunset, disregarding twilight. It is obvious that CLEOMEDES did not care about the latitude implied in his numerical example, as long as the monthly increase and decrease rates could be expressed in a simple way, 1/2 hour, 1 hour, and 1 1/2 hour. CLEOMEDES gives no mathematical proof of his statement; apparently, he had none to offer, and was quite satisfied with a numerical example. We may assume that the duodecimal rule was of Egyptian origin, and was derived from the lengths of the scales of prismatic inflow clocks—not from mathematical considerations involving the successive positions of the sun in the ecliptic. Figure 3 shows the straight sloping lines of a prismatic diagram and the sinusoidal distribution of CLEOMEDES' values plotted on equidistant ordinates; both the Egyptian inventor of the 1:2:3 diagram for prismatic inflow clocks and the Egyptian astronomer who first formulated the duodecimal rule concerning the monthly rate, were so close to the true solution of the problem that their achievements deserve a place of honor in the history of Egyptian science.

The traditional dimensions of outflow clocks offer us another example of the expression of a physical law by the judicious use of simple numerical relations. A " flower pot " with a bottom radius of 6, an upper radius of 12, and a height of 18 fingerbreadths —again a 1:2:3 construction rule—differs but little, in its graduated upper two-thirds, either from the paraboloid or from the truncated cone with an inclination of 77° which are characterized, in their upper two-thirds, by levels which sink uniformly—theoretically in the case of the paraboloid, practically in the case of the 77° frustum (20).

8. *Models of inflow clocks.*

In the case of the prismatic inflow clocks—as distinguished from the case of the " flower-pot " outflow clocks mentioned

(20) BORCHARDT, *loc. cit.*, p. 16.

in the preceding paragraph,—the ratio of the width to the height was dictated by practical and aesthetical rather than by theoretical considerations : it was a compromise between the tendency to lengthen the scales by reducing the cross section, and the necessity of reducing the depth, in order to simplify the engraving and reading of the scales. We shall see that the simple ratios of 1:1, 1:2, and 1:3, between the width and the height, must have been in use. The longest scale of the prism being, traditionally, 14 fingerbreadths, the side of the rim had to be, in the case of the 1:2 ratio, 7 fingerbreadths; the cylinder of Edfu is 14 fingerbreadths deep, and the developed horizontal length of its diagram is 28 fingerbreadths.

The emptying of an inflow clock offered architectural and sculptural opportunities which could not have escaped the Egyptians. In the case of an outflow clock, its very operation, during the night, left but a small amount of water, in the lower third of the " flower pot," at sunrise; since the clock had to be filled to the upper level, in the evening, this " residual " water was, probably, drained off but occasionally. In the case of an inflow clock, the result of a night's running was a prism full of water which had to be drained, before the next evening, to the bottom of the scale corresponding to the current month; the evacuation of the water, through the cynocephalos squatting at the base of the prism, could be easily adjusted in such a manner that it lasted until evening; the decreasing volume of the outflow was irrelevant, since no measurement of time was involved. A little rectangular basin at the foot of the prism, in front of the cynocephalos, could, therefore, become a decorative as well as a useful part of the draining arrangement; it was but natural to incorporate, into the design of the rectangular basin, a sun clock of the " flight-of-stairs " type, if the prismatic inflow clock happened to be located in a court.

Almost a century ago, C. LEEMANS (21) gave the following description of the Leiden model of an inflow clock :

" *Terre émaillée.* CYNOCEPHALE, accroupi entre deux réservoirs, dont

(21) Monumens égyptiens du Musée d'antiquités des Pays-Bas à Leide, p. 16, Pl. XIX, no. 47. Leiden, 1842. Dutch edition, p. 17.—Pl. XIX, no. 23 represents a squatting cynocephalos, on a slab, with an opening below the cynocephalos; apparently, a fragment of a water clock or of a model of a clock.

le plus grand se trouve derrière l'animal, l'autre, plus petit, devant ses pieds; un trou est percé de l'un dans l'autre de ces réservoirs et un escalier de six gradins conduit sur le bord du dernier. Ce petit monument nous offre peut-être le modèle d'une *clepsydre* Égyptienne, analogue à celles que décrit HORAPOLLON, *Hierogl.* I. 16."

The Leiden model, shown in Figure 4, is made of green faience; it is 44 mm. high; the water clock is formed by a low, rectangular prism; there is no graduation, of course; the rectangular shape indicates that the model represents an inflow clock which must have been different from the sqaure prototype of the Edfu clock. The outside walls of the Leiden model show some tapering.

The GRÉAU-MORGAN model of a rectangular inflow clock is reproduced on Plate 4, top, left; see also the excellent reproduction

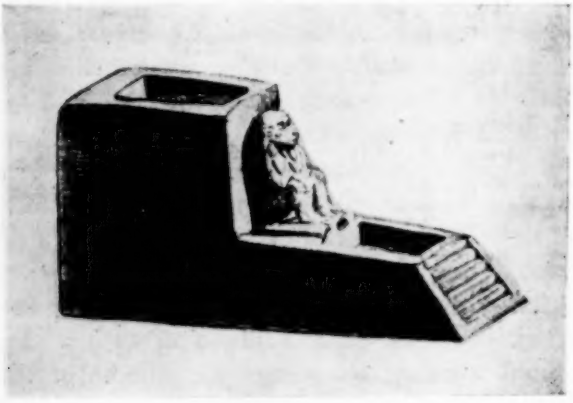

FIG. 4. — Leiden model of a prismatic inflow clock. Height, 44 mm. After : C. LEEMANS, Monumens égyptiens, P. XIX, no. 47. Leiden, 1842.

in the catalogue of the GRÉAU-MORGAN collection, Pl. 294.6; green faience; the height of this (late dynastic?) model is 55 mm. According to FROEHNER's (22) description, it is a " gaine carrée, portant sur le devant un cynocéphale accroupi "; the Metropolitan Museum (23) lists it as a " Nilometer. In the form of a tank, with 6 steps and with figure of ape sitting on the front." The

(22) Collection JULIEN GRÉAU. Verrerie antique. émaillerie et poterie appartenant à M. JOHN PIERPONT MORGAN. Texte rédigé par W. FROEHNER. Page 234 and Pl. 294.6. Paris, 1903.

(23) Acc. No. 17.194.2341.

Models of inflow clocks and a votive offering. Late dynastic?

Top, left : GRÉAU-MORGAN model. Acc. No. 17.194.2341. Height, 55 mm.
Top, right : MASPERO model. Acc. No. 86.1.93. Height, 87.5 mm.
Bottom : *šb.t* from Sakkāra. Acc. No. 10.176.45. Height, ca. 4 5/8 in.
Courtesy of The Metropolitan Museum of Art.

Medinet Habu. XXth dynasty. Astronomical ceiling. Western part.

Courtesy of The Oriental Institute,
The University of Chicago.

Medinet Habu. XXth dynasty. Astronomical ceiling. Eastern part.

Courtesy of The Oriental Institute,
The University of Chicago.

Ramesseum. XIXth dynasty. Astronomical ceiling. East is on the right.

Courtesy of Dr. Siegfried Schott.

hollow rectangular inflow clock rests on a base which has, in front of the cynocephalos, a shallow rectangular basin; the cynocephalos sits on a small rectangular block pierced by the draining orifice. The front wall of the main base is slightly inclined, and a double row of steps ascends to the rim of the basin; the double row of steps below the cynocephalos is marked on a vertical wall; these four rows may be considered as symbolizing the 24 hours, and originally they must have belonged to a sun clock of the "flight-of-stairs" type leading up to the cynocephalos. The inside of the clock is prismatic, the outside shows a slight tapering (the side walls are 40 mm. high, 40 mm. at the base, and 38 mm. at the top).

The Cairo model has been reproduced and discussed by BORCHARDT (24) and by SLOLEY (25). It will, therefore, suffice to state that the inside walls of the clock seem to be vertical; the horizontal cross section is a square; the ratio of the width to the height is about 1:2; the tapering of the outside walls is pronounced; the total height is 108 mm.; the overflow of the shallow basin in front of the cynocephalos runs down three steps. Like the other models, it has no graduation on the inside; the fact, however, that its cross section is square and its width-to-height ratio is 1:2, permits us to assume that the full-size clock represented by the Cairo model could have been 7 fingerbreadths wide and 14 fingerbreadths deep; it is, therefore, possible that the Edfu diagram originated in a clock similar to the one represented by the Cairo model.

A hitherto unpublished model of a prismatic inflow clock is reproduced on Plate 4, top, right, through the courtesy of the Metropolitan Museum of Art (26). It was described, in the list accompanying MASPERO's second shipment, 1886, as a "light green porcelain Nilometer." The height of this late-dynastic model is 87,5 mm. The hollow square prism rests on a base which had, no doubt, a basin in front of the cynocephalos; the knees of the cynocephalos are broken off; the draining hole is at the very bottom of the prism; the height of the prism is about

(24) *Loc. cit.*, p. 25.

(25) *Ancient Egypt*, 48-49, 1924. *The Journ. of Eg. Arch.*, 17, Pl. XXI and p. 176, 1931.

(26) Acc. No. 86.1.93.

three times its outside width; no inside graduation, of course. The square prism of the full-size clock could, possibly, be lifted from its base by means of prominences near the top of the side walls; the existence of a vertical sun dial on one of the side walls of the full-size clock is improbable, for reasons of symmetry; the prominences may be vestigial handles reminiscent of the time when the emptying of an inflow clock was accomplished by tipping the prism, not by draining it through a cynocephalos. By analogy with outflow clocks which had a graduation covering the upper two-thirds of the vessel, a square prismatic inflow clock of the proportions represented by the MASPERO model could have a diagram, of the type reproduced in Figure 1, covering the upper two-thirds only of the inside walls.

These four models prove that prismatic inflow clocks must have existed, although no fragments of full-size prismatic clocks are known. The Edfu diagram may be considered as a degenerated descendant of the diagrams which originated in tall square prismatic clocks. We know nothing of the graduation of low rectangular prismatic clocks; it is possible that the long side walls were divided into three equal parts and contained the scales of the months preceding and following the equinoxes, while the subdivision of the narrow front and back walls into three equal parts furnished the scales of the months preceding and following the solstices.

9. *Votive offerings.*

We have dealt, in the preceding section, with a class of objects which were, beyond any reasonable doubt, models of inflow clocks; they were, in all probability, used as votive offerings. The objects we are about to discuss were used as votive offerings—inscriptions prove it; it is highly probable, but not quite certain, that they were intended to represent inflow clocks.

The *šb.t* reproduced on Plate 4, bottom, is thus described by the Metropolitan Museum (27) :

" Figure of Cynocephalus. From Sakkara. Glazed faience. The figure is represented as a squatting mummy on the *heb* festival sign. There is a pillar behind, which is broken off at the top. Glaze, very thin, pale blue. Execution exquisite. Perhaps a votive offering."

(27) Acc. No. 10.176.45.

This (late-dynastic?) *šb.t* is about 4 5/8 in. high. The square pillar behind the cynocephalos had, apparently, a V-shaped notch at the top, running from the front to the back side of the pillar. We have seen that horizontal grooves on a vertical wall may represent a " flight-of-stairs " sun clock; whatever the original meaning of a notch at the top of a hieroglyph representing a prism or cylinder might have been, there is no reason why " chevron " markings on the inside of the front and back of a square prismatic inflow clock of the CEIK type should not be represented by a V-shaped notch at the top of a square prism not weakened by hollowing. The alabaster markings on the *ḥb* have, of course, nothing to do with the " chevrons " of the CEIK diagram, but their presence is very appropriate. The whole object is treated symbolically rather than realistically. The prism behind the cynocephalos is of the tall type, but the relative height of the cynocephalos and of the prism reminds us of the Leiden and the GRÉAU-MORGAN rather than of the Cairo and the MASPERO models.

Here is a partial quotation from a somewhat awkward description (28) of a similar object, PRICE No. 3796 :

" Shebt or Ushebt, an object which has been said to be the Clepsydra... it represents a cynocephalous ape seated upon the ground in human form, leaning against a column... H. 7 in. Faience, has had a green glaze."

Of the elements entering into the making of the *šb.t* group, the squatting cynocephalos gradually assumed dominating proportions; both the *ḥb* and the *nb* seem to have been used indiscriminately; the degeneration of the *ḥn*—to us, the really essential part of the *šb.t* group—from a separate square prism with a V-shaped notch at the top to a mere slab behind the back of the cynocephalos, appears to be a late-dynastic development limited to plastic—as opposed to epigraphic—*šb.t* groups.

As an example of a late-dynastic plastic *šb.t* group consisting of a cynocephalos, with a slab at his back, squatting on a *ḥb*, PRICE No. 4322 could be quoted (29), a green faience figure, 4 in. high. It is so similar to PRICE No. 3796 that the interpretation of the slab as a degenerated prism seems to be fully justified.

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(28) A. Catalogue of the Egyptian Antiquities in the Possession of F. G. HILTON PRICE, vol. 1, p. 450, No. 3796. London, 1897.

(29) *Loc. cit.*, vol. 2, p. 38 and Pl. XII, No. 4322. London, 1908.

The Metropolitan Museum (30) has a late-dynastic miniature *šb.t* group in which the cynocephalos leans against a slab notched at the top; he squats on a *nb* showing wickerwork detail. To the modern profane eye, this miniature votive offering looks like a monkey in a rocking chair. It is of pale green faience, and is about 2 3/8 in. high.

Figure 5 represents AMENHOTEP III (31) offering to the goddess Maut a *šb.t* which might be described as a prismatic *ḥn* receptacle with a squatting cynocephalos attached to its front wall, presented on a *nb*; the emphasis seems to be on the *ḥn* receptacle rather

FIG. 5. — Votive offering. Amenhotep III. About 1400 B.C.
From : A. GAYET, Le temple de Louxor, *Mém. miss. arch. fr. au Caire*, 15, Pl. 68, fig. 195. Paris, 1894.

than on the cynocephalos; at the top of the *ḥn* prism there is a V-shaped notch. The offering of such a *šb.t* group to a goddess by AMENHOTEP III appears to have set a precedent. Although the inscriptions—which mention the *šb.t*—offer no explanation of the nature of the transaction between AMENHOTEP III and

(30) Acc. No. 22.2.25.

(31) A. GAYET. Le temple de Louxor. 1er fascicule. Constructions d'AMÉNOPHIS III. *Mémoires miss. arch. fr. au Caire*, 15, p. 109, Pl. 68, fig. 195. Paris, 1894.

the goddess, it is difficult to escape the impression that the object on the *nb* sign represents a prismatic inflow clock. If the interpretation of the notch at the top as an allusion to the " chevrons " characterizing a CEIK diagram be correct, its presence on the side walls—as opposed to the front and back walls of the plastic *šb.t* shown at the bottom of Plate 4—may be due either to the Egyptian profile conventions or to the actual construction, under AMENHOTEP III, of a prismatic inflow clock of the CEIK type with " chevrons " on the inside of the side walls and a draining hole under an equinoctial scale, as in the case of the Edfu clock.

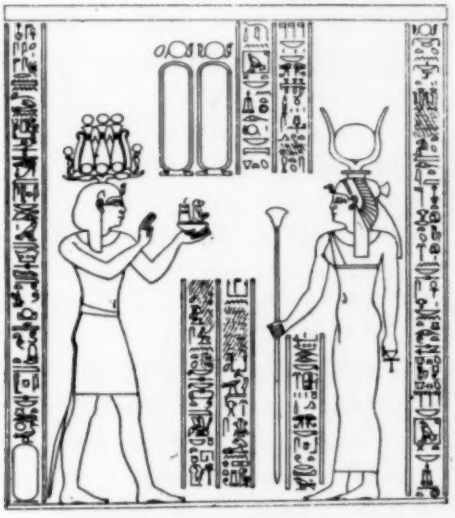

FIG. 6. — Votive offering. Ptolemaic. About 50 B.C.
From : A. MARIETTE, Dendérah, 3, Pl. 22*a*'. Paris, 1871.

The time of AMENHOTEP III is characterized by a remarkable activity of makers of time-measuring devices : in addition to the Karnak alabaster clock, several fragments of instruments bearing his cartouches and based on videly differing principles have survived; it is not impossible that ANEN (32), the " astronomer royal " of AMENHOTEP III, was partly responsible for this activity of the instrument makers. If a completely unknown object were represented on a *nb* held in the hand of AMENHOTEP III, it would be reasonable to assume that it is a time-measuring instrument;

(32) A statue of this priest-astronomer is in Turin.

if the object happens to be a square prism with a squatting cynocephalos attached to its front wall, the interpretation of the object on the *nb* as a model of an inflow clock seems to be fully justified.

Figure 6 represents a Ptolemaic (33) counterpart to the XVIIIth dynasty votive-offering scene. In 1875, A. MARIETTE (34) made the following comment on the Ptolemaic inscription :

" Le texte n'explique pas le sens de l'offrande que le roi présente à la déesse. Hathor prend le titre vague de « maîtresse des yeux ». Elle dit au roi : « J'accorde que tes yeux voient pour des millions d'années le... que tes yeux soient préservés de tout mal ». Le roi intervient dans la cérémonie comme fils de Thoth, apportant la clepsydre à sa mère."

It will be noticed that while the prism of the plastic votive offerings, discussed in the beginning of this section, gradually degenerated into a meaningless slab, the more conservative epigraphic representations preserved the vessel shape of the object behind the cynocephalos; the tapering is pronounced, and the notch at the top is present, both in the center and at the bottom of Figure 6; it is possible that the Ptolemaic offering represents an inflow clock with a circular—not with a square—cross section.

There are numerous representations, in the published epigraphic material (35), of objects which look like inflow clocks or inflow clock models; a thorough study of these inscriptions is desirable, now that the originally prismatic shape of inflow clocks may be considered as well established. The tapering of the vessel, the presence or absence of the notch at the top, of the curved (inflowing water ?) or straight (floating index ?) line at the top, of the horizontal bands (level marks ?), etc., ought to be taken into consideration, and the chronological order of their appearance established.

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(33) A. MARIETTE, Dendérah. Texte : Paris, 1875. Planches, t. III : Paris, 1871. Our Fig. 6 is a reproduction of Pl. III.22*a*' (Grand temple, crypte no. 2). Concerning the empty cartouches, MARIETTE wrote, p. 48 : " Mais si les cartouches sont vides, il n'en est pas de même des noms de règne qui sont introduits pleins dans le texte courant des cryptes n^{os} 2 et 8. Là, deux rois se révèlent par des qualifications qui ne laissent aucun doute sur la place qui leur est due dans le canon des LAGIDES. Ces deux rois sont PROLÉMÉE XI et PTOLÉMÉE XIII."

(34) *Loc. cit.*, p. 241.

(35) See, e.g., the references in GARDINER, *loc. cit.*, sign-list; ERMAN-GRAPOW's dictionary; BORCHARDT, *loc. cit.*, p. 26.

10. *Water clocks and astronomical ceilings.*

In 1897, G. DARESSY (36) published a detailed description of the astronomical ceiling of Medinet Habu, from which we quote the following passages :

" ... une salle de huit mètres de longueur sur quatre de largeur, dont le plafond était en forme de voûte surbaissée... Ces dalles [du plafond] étaient toutes brisées, heureusement on en a retrouvé dans les décombres une partie suffisante pour pouvoir rétablir les trois quarts de la toiture... La voûte est ornée de sujets astronomiques qui donnaient la copie presque textuelle d'un plafond du Ramesséum. Le tableau, encadré par la légende royale de Ramsès III, est divisé en trois registres."

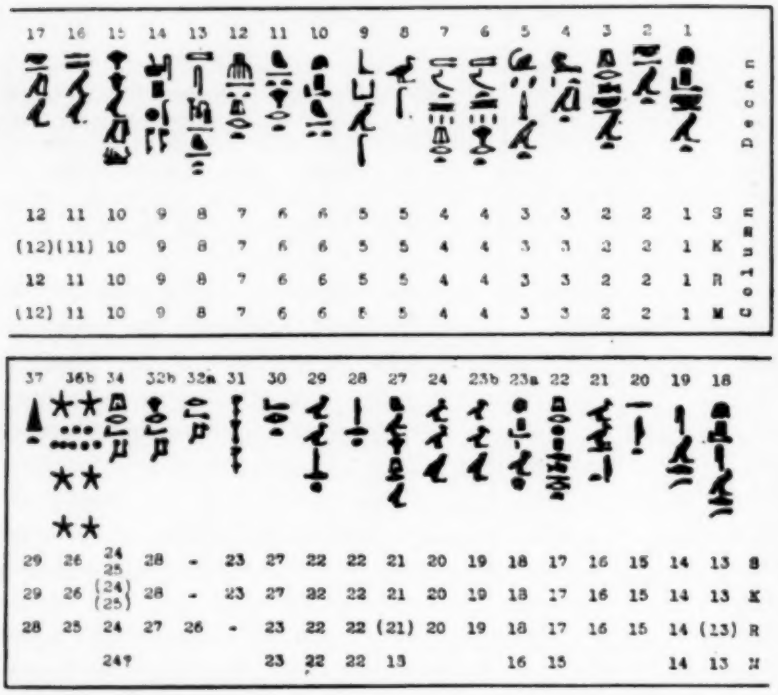
In 1904, the Karnak alabaster clepsydra was discovered; its exterior decoration, " ... ces tableaux, analogues aux peintures des plafonds astronomiques du Ramesséum et de Médinet Habou " (37), did not prevent the Medinet Habu ceiling from being neglected. Plates 5 and 6 reproduce unpublished photographs of the Medinet Habu ceiling. For the sake of completeness, I have added, on Plate 7, a reduced reproduction of a composite photograph of the Ramesseum ceiling. A detailed comparative study of the exterior decoration of the Karnak alabaster clock and of the two ceilings reproduced on Plates 5 to 7 will appear elsewhere; in the present paper, I shall limit myself to a few remarks concerning the decanologues of the Karnak clepsydra and of the ceilings of SENMUT, the Ramesseum, and Medinet Habu.

In my paper dealing with the SENMUT (38) ceiling, I have shown that the Ramesseum decanologue followed the same tradition as the SENMUT decanologue, whereas the SETI decanologue followed a different tradition. Two more decanologues may now be added to the SENMUT-Ramesseum tradition—the Karnak and the Medinet Habu lists. Table III shows these four lists at a glance; since the SENMUT ceiling is older than the Karnak clepsydra, I have reproduced the SENMUT-ceiling spelling of the names of the decans; the numbering of the decans is the same as in my tabulations of the decanologues of the Middle Kingdom (39) and of the XVIIIth and XIXth dynasties (40).

(36) Notice explicative des ruines de Médinet Habou, pp. 154-57. Cairo, 1897.
(37) DARESSY, Deux clepsydres antiques, *loc. cit.*, p. 10.
(38) *Isis*, 14, 320, 1930.
(39) *Osiris*, 1, 507, 1936.
(40) *Isis*, 14, 317-18, 1930.

TABLE III

Decanologues of the XVIIIth, XIXth, and XXth dynasties



S — SENMUT ceiling	XVIIIth dyn., about 1500 B.C.
K — Karnak clepsydra	XVIIIth dyn., about 1400 B.C.
R — Ramesseum ceiling	XIXth dyn., about 1250 B.C.
M — Medinet Habu ceiling	XXth dyn., about 1175 B.C.

Although the state of preservation of the Medinet Habu ceiling leaves gaps in the western half of the table, it is obvious that the Medinet Habu and the Ramesseum decanologues differed, in the Orion region, from the SENMUT and the Karnak lists.

11. *Acknowledgments.*

I hereby express my thanks to the following men and museums :

To Dr. W. D. VAN WIJNGAARDEN, for written information concerning the Leiden model reproduced in Figure 4.

To the Metropolitan Museum of Art, for the photographs reproduced on Plate 4. The MASPERO model is a hitherto

unpublished item. I believe that no photograph of the votive offering from Sakkāra has been published before.

To Dr. H. H. NELSON, for the hitherto unpublished photographs of the Medinet Habu ceiling reproduced on Plates 5 and 6.

To Dr. SIEGFRIED SCHOTT, for the original positives on which Plate 7 is based. To Mr. A. C. BOECKER, of the Fogg Museum staff, for his excellent enlargements and reductions which led to the final composite positive. It was, unfortunately, impossible to preserve the beauty and legibility of this Ramesseum photograph in the reduced half-tone reproduction.

Carnegie Institution of Washington. A. POGO.

The Babylonian Tables of Reciprocals

In my paper, "The Sources of AL-KHOWARIZMĪ's Algebra" (1), I referred to the Babylonian Tables of Reciprocals and suggested that they may be regarded as the origin of some minor mediaeval operations with reciprocals. On closer examination of the whole material, as now presented by O. NEUGEBAUER (2), I came to the conviction that there are no reciprocals in these tables and that it is, therefore, a misnomer to refer to them as Tables of Reciprocals.

In first line, such tables would serve no useful purpose at all. We understand perfectly well that there was a practical need for the other mathematical tables, such as the multiplication tables, the tables of squares and cubes, the exponential tables, giving a series of the successive powers of n (n^2—n^{10}), and the so-called functional tables, for $n^2 + n^3$ (3). But to set up tables of reciprocals seems to us entirely superfluous. Once the conception of the reciprocal is formed and we are told that the reciprocal of n is $\frac{1}{n}$, we know already the whole art of the reciprocals. There is no special difficulty, nor any magic in the conversion of n into $\frac{1}{n}$, or of $\frac{n}{m}$ into $\frac{m}{n}$.

In second line, we see that all these tables do not contain the simple reciprocals of the integers, but in addition to that a new, very essential element, and that is the expression of the so-called reciprocal in the form of a sexagesimal fraction. Moreover, a

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(1) See § 10. The paper appeared in *Osiris*, I, a volume of studies in honor of PROFESSOR DAVID EUGENE SMITH, presented to him on his 76th birtday (pp. 263-77).

(2) See MKT (= *Mathematische Keilschrift-Texte*), I, p. 5ff; VM (= *Vorgriechische Mathematik*), p. 4ff; QS B (= *Quellen und Studien zur Geschichte der Mathematik, Abteilung B, Studien*), I, pp. 188ff, 452-63; II, p. 199ff.

(3) See MKT, I, pp. 7-8.

plain table of reciprocals would have to give a list of all the integers. Our tables, however, contain only the reciprocals of such integers which can be converted into finite sexagesimal fractions. This shows clearly that the main purpose of the table is not *the formation of reciprocals*, but their *transformation into sexagesimal fractions*. This conversion of common fractions into sexagesimal fractions certainly does serve a very useful purpose, comparable in importance to our modern transformation of common fractions into decimal ones. It means the deliberate and planful propagation of the idea of " the extension of the integer scale to fractions," it means that " the subunits are to be treated in the same manner as the multiples " (4), and that there should be no fractions at all. In short, it means nothing less than a Babylonian anticipation of the decimal fractions going back to the time of *c.* 2250 B.C., to which period the oldest tables belong (5). Now, of course, this conversion of the common fractions into sexagesimal ones does require the preparation of special tables, as the operation entails considerable difficulties.

Finally, I believe that there are no reciprocals at all in these tables, but only plain, common fractions. In my opinion, the term *igi*, or *igi gál-bi*, has no relation whatever to reciprocals. The error of seeing reciprocals where in reality there are only fractions is due to the peculiar Babylonian way of writing fractions and to the peculiar arrangement of the tables. The standard type of such a table consists of a list of 30 pairs of numbers, the product of which appears to be, on the surface, 60. The two numbers of each pair face each other on two opposite columns and read as follows (6) :

2	30	6	10	12	5
3	20	8	7.30	15	4
4	15	9	6.40	16	3.45
5	12	10	6	18	3.20 etc.

According to the sexagesimal scale, the two-place numbers 7.30, 6.40, and 3.45 must be read as $7 + \frac{30}{60} = 7\frac{1}{2}$, $6 + \frac{40}{60} = 6\frac{2}{3}$

(4) See SARTON's paper on the Decimal Fractions in *Isis*, 23, 1935, p. 163.
(5) See QS B, I, p. 452, notes 4, 5.
(6) See MKT, I, p. 9; VM, p. 10.

and $3 + \frac{45}{60} = 3\frac{3}{4}$. And if both sides of the row are taken as integers, each number pair gives the product 60. Owing to the indetermination of the absolute place value in the Babylonian notation, there is also a possibility to read the left side numbers as unit integers and the right side numbers as sexagesimal fractions of the first degree. The number 30 would be $\frac{30}{60} = \frac{1}{2}$; $20 = \frac{20}{60} = \frac{1}{3}$; $7.30 = \frac{7}{60} + \frac{30}{60^2}$, etc. Each pair would, therefore, consist of an integer on the left side and its sexagesimal reciprocal on the right side and thus represent a pair of reciprocals. NEUGEBAUER decided in favor of this interpretation and he had to explain accordingly the words *igi... gál-bi* (7), usually accompanying these numbers, as meaning " the reciprocal of 2 is 30, " etc.

It was already said above that from the mathematical point of view there is no reason why we should take the two numbers as reciprocals. And now I wish to state that from the philological point of view there is still less justification for interpreting *igi... gál-bi* as the reciprocal. The lack of a philological foundation is more or less admitted by NEUGEBAUER (8). The original meaning of *igi* is "eye." Hence NEUGEBAUER, following POEBEL, interprets the phrase *igi gál-bi* as meaning " to put an eye upon, to look upon " and then " to distinguish, divide." This etymology looks to me too far fetched, especially if we take in consideration that the word *gál-bi* is often omitted and we have only *igi* 2-30 etc.

I, therefore, believed, from the outset, that the term *igi*, eye, must also have had the further meaning " part," and, if placed before or after a number, it must have indicated that this number *n* is the *n*th part of *one*, or a unit fraction with the denominator *n*. Thus *igi* 2 is 1/2, *igi* 3 is 1/3 a.s.o. In some instances (9) NEUGEBAUER himself admits that it is used in the sense of a " Nenner," a denominator. On further investigation, I found in MUSS-ARNOLT, *Dictionary of the Assyrian Language*, p. 66-67, that *inu* (10) has the meanings " eye, well, part." The conclusion

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(7) The usual form is *igi* 2 *gál-bi* 30 etc.; frequently the word *gál-bi* is missing.
(8) See MKT, I, p. 24; VM, p. 7.
(9) See MKT, II, Index, pp. 17 and 28 under *igi* and *igu*.
(10) Corresponding to *'ayyin*.

is therefore justified that the Sumerian-Akkadian *igi* had the same meanings as the Babylonian *inu* and also denoted a part. Standing before a number it was merely the symbol of a fraction, corresponding in form and method to the Egyptian symbol of a fraction. For the Egyptians, too, expressed each unit fraction (11) through the word *r*, " mouth, part," which was placed before the number *n*. The mouth as the symbol for the part and fraction is still preserved in the Akkadian *šinipu*, meaning " two mouths, two parts, 2/3." Another Akkadian term is *šittā qātā*, " both hands, two parts, 2/3 " (12). In Biblical Hebrew we still have the term *yad*, " hand " for " part," and even *shtē ha yadot*, " both hands " for the remaining 2/3 occurs once (13). The term *peh*, mouth, for " part," is also preserved in the phrase *pi shnayyim*, " the mouth of two, two mouths," for two thirds (14).

In addition to the " hand " and " mouth " the Sumerians, as we now see, employed also the " eye " as the symbol and term for part and fraction. Hence the phrase *igi* 2 *gál-bi* 30 must be interpreted as : " 1/2 put it down, write it 30. (1/60)." In the two rows of numbers facing each other in these tables, the number on the left side is not an integer, but a fraction. The sexagesimal fraction on the right side is not its reciprocal, but its equivalent. The two numbers represent an equation and not a pair of reciprocals. Instead of Tables of Reciprocals, we should, therefore, properly call them Tables for the Conversion of Common Fractions into Sexagesimal Fractions. That this conversion of the common fractions into sexagesimal ones was the real purpose of the Tables of Multiplication was clearly recognized by NEUGEBAUER (15). And yet he failed to draw the necessary conclusion with regard to the so-called Tables of Reciprocals, which are only an auxiliary means for the Tables of Multiplication.

The conception of *igi* as a " reciprocal " is quite impossible

(11) Where the denominator was higher than four. For the fractions 1/2, 2/3, 1/4 they had special symbols.

(12) See VM, p. 89; MKT, II, p. 23.

(13) II *Kings*, 11, 7.

(14) See *Dt.* 21, 17; *Zech.* 13, 8; II *Kings*, 2, 9.

(15) See QS, B. I, 1930, pp. 190, 192 and 193.

in those tables in which the product of the number pair gives 10 (3—3.20; 4—2.30; 5—2), or 70 (2.30—28; 3—23.20) (16). Here the fraction on the left side is not a unit fraction but a general fraction with the numerator 10 or 70. Here the term *igi* 3 cannot mean the reciprocal of 3, but only " the third part," a general fraction with the denominator 3. Since the beginnings and ends of these tables are missing, we must assume that in those parts of the tables the instruction was given that the numerator is 10, respectively 70. At the end of some of the tables containing fractions we find the words *igi gál* 1 *-da-kam*, meaning " parts of one " (see MKT, I, p. 26). They indicate that the numerator of these tables is *one*, that they deal with unit fractions. In like wise, the tables containing number pairs giving the product of 10 or 70 must have been characterized by the words *igi gál* 10 *da-kam*, or *igi gál* 70 *da-kam*, " parts of 10," or " parts of 70." A clear definition of the term *igi* is still preserved in certain vocabularies in which the fraction terms are also expressed through plain ordinal numbers. We read there (MKT, I, p. 28 f.): *igi* 3 *gál-la—šalša-a-tu ; igi* 4 *gál-la—ribuutu* etc. Which means : " part 3—one third "; " part 4—one fourth." This is as if we would write today : " 1/3 = one third; 1/4 = one fourth."

These tables for the transformation of common fractions into sexagesimal fractions were very common and widespread. NEUGEBAUER lists over one hundred of them (MKT, I, p. 34-5). They were, as it seems, regular school texts, or school tables, put in the hands of the teachers and students. Essentially and fundamentally, they were school texts propagating the idea of the creation of a unified scale for both integers and fractions, teaching the theory of the removal of the barrier between integers and fractions. In short, they represent the Sumerian anticipation of the decimal fractions. Around 1360 A.D. the French-Jewish astronomer IMMANUEL BONFILS wrote down his short note in which he first expounded the theory of the decimal fractions (17). More than two hundred years later, in 1585, the Dutch engineer SIMON STEVIN published his *De Thiende*. But almost 4000 years before, in 2250 B.C., the mathematicians of Ur Kasdim taught

(16) See MKT, I, p. 30ff; VM, p. 16.

(17) See my article in *Isis*, 25, 16-45.

already this newfangled idea of BONFILS, and the public schools of Mesopotamia had already adopted the revolutionary system of STEVIN.

We may thus learn to appreciate the legacy of Babylonia in the field of mathematics. Our ingenious modern system of decimal notation is distinguished by three fundamental features : the place value, the zero, and the decimal fractions. In principle, all of them were already contained in the sexagesimal notation of the ancient Babylonians. The third feature was re-invented by the Europeans. The first two features reached us by the way of the Hindus and Muslims. Were the Greeks and Romans entirely ignorant of these devices? This problem still awaits its solution.

New York City. SOLOMON GANDZ.
February 2, 1936.

P.S.—Dr. SARTON was kind enough to call my attention to THUREAU-DANGIN's review of MKT in the *Revue d'Assyriologie*, vol. 33, 1936, p. 55 ff., where the *igi* question is discussed. THUREAU-DANGIN, too, rejects the etymology of POEBEL. However, the one suggested by himself is also not satisfactory. Originally, in his *History of the sexagesimal system*, p. 27, THUREAU-DANGIN did guess the correct meaning of *igi* to be " part," but later he gave it up. THUREAU-DANGIN further justly points out that in those tables which, at the beginning, display the phrases : *igi* 1/2—30, *igi* 2/3—40, there are plainly only equations, giving the conversion of common fractions into sexagesimals, and no reciprocals. Sometimes the number 40 is explained by *šittā qātā* (18), to indicate that its value is 0.40, or 2/3. It is worth while noting that the Egyptian-Babylonian method of expressing a fraction by the cardinal number with the word " part " was also employed by the Hindus (19).

In conclusion I wish to emphasize again that NEUGEBAUER clearly recognized the importance of these tables for the conversion of the common into sexagesimal fractions. His *Mathematische*

(18) See MKT, I, p. 97, v. 4.
(19) See DATTA-SINGH, *History of Hindu Mathematics*, p. 185.

Keilschrift-Texte will remain the fundamental work on Babylonian mathematics and one of the foremost contributions to the history of mathematics. When, in 1926, I first established the fact of the Babylonian origin of the term " algebra " (20) and uttered the conjecture that the Babylonians must have cultivated the science of algebra, I hardly dreamt of it that the next ten years would bring such a splendid confirmation of my vague hypothesis. For this almost spectacular restoration of the Babylonian algebra the scholarly world will remain indebted to DR. NEUGEBAUER.

SOLOMON GANDZ.

(20) See " The Origin of the Term Algebra," *The American Mathematical Monthly*, 1926, p. 437ff.

Decimal division of scales before the metric system [1]

The decimal subdivision of linear scales appears to have been quite common before the metric system was finally established by law in 1795.

The collection in the Science Museum includes numerous sectors, slide rules, and scales dating from the 17th and early 18th centuries which bear a line of inches subdivided into tenths.

These include :

Inv. No.

1917-9 (1) EVERARD's slide rule which is engraved " Is. CARVER Fecit 1689."

1917-10 (2) An EVERARD slide rule as modified by C. LEADBETTER, which dates from the early 18th century.

1907-108 (3) An early slide rule made by VOSTER of CORK in 1742.

1917-92 (4) A 6" sector of brass and ivory engraved " CARVER Fecit." Dates from end of 17th century.

1917-93 (5) A 6" brass sector engraved " CULPEPER Fecit." Late 17th or early 18th century.

1915-396 (6) A 12" boxwood sector of the late 17th or early 18th century.

1919-3 (7) 6" gunners' callipers made by H. GREGORY. Middle of the 18th century.

1922-235 (8) Triangular wooden Quadrant inscribed " TOBIAS WILDBOARE 1683."

(Against each object in the list its Inventory Number is given to facilitate reference).

This list includes only those objects of which there can be little doubt that they antedate the introduction of the metric system by at least 50 years. A great many other decimally divided objects in the collection date from the late eighteenth century.

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(1) Answer to Query 57 (*Isis*, 24, 432).

The grouping of the divisions of a line into tens is quite old. For instance in " The Mathematical Jewel " by JOHN BLAGRAVE, 1585, on page 4 there is an illustration of a scale of which every tenth division is larger than the others. Every tenth division is numbered, but the numbering is 10, 20, 30 etc. up to 100, so that there can be no question of decimal fractions. A seventeenth century 12" brass plotting scale (Inv. No. 1917-84) in the Science Museum also exhibits this feature of the main divisions being labelled 10, 20, 30 etc. in order that the least division shown shall be unity. The same type of graduation is to be found in an illustration in one of the earliest books on the sector, namely " The Making and Use of the Geometricall Instrument Called a Sector " by THOMAS HOOD, London, 1598. Throughout HOOD's book however ordinary fractions are used and there is no suggestion of decimal arithmetic.

It was perhaps not until logarithmically graduated scales had been invented by GUNTER in 1620 that it was realized that the zeros need not always be included when numbering the graduations. The early books dealing with these logarithmic scales usually take care to explain that although the graduations are from 1 to 10 the unit may stand for any multiple or submultiple of 10. (See, as an example of such an explanation, " The Art of Practical Measuring by the Sliding Rule " by HENRY COGGESHALL, 5th edn., London, 1732, page 28). Logarithmic scales have from their inception always been subdivided decimally, as is the case on an early slide rule in the Science Museum (Inv. No. 1898-30) which is engraved " Made by ROBERT BISSAKER, 1654, for T. W.," and also on a two-foot GUNTER's scale (Inv. No. 1915-549) which dates from the latter part of the 17th century.

The diagonal scale of which the invention is attributed to LEONARD DIGGES in the 16th century also arranges for a decimal subdivision of the scale. There are examples of diagonal scales in the Science Museum which were made by JONATHAN SISSON (died in 1749) and JOHN BIRD (died in 1776) (Inv. 1900-161; & Inv. 1911-184). Both of these scales bear, apart from the diagonal scale, a scale of inches, which are subdivided into tenths. An illustration of, and instruction for constructing, a diagonal scale are to be found in " Baculum Geodaeticum " by ARTHUR HOPTON, 1610, page 11.

Very frequently when the question arose of dividing a length into a large number of subdivisions the number chosen was some multiple of ten. In the *Philosophical Transactions*, Volume II, 1667, on page 457 there is " An extract of a letter written by Mr. RICHARD TOWNELEY to Dr. CROON, touching the Invention of Dividing a Foot into many thousand parts, for Mathematical purposes," and in it occurs the phrase " every last division containing 1'0 of an Inch." (2) A diagonal scale of 100 parts in a quarter of an inch is mentioned on page 27 of " Timber Measure by a Line... " by HENRY COGGESHALL, 1677.

In surveying too the advantages of decimal division were realized by EDMUND GUNTER (died in 1626) who invented a chain of length 66 feet containing 100 links. A description of this chain and its use is to be found in WILLIAM LEYBOURN's " The Compleat Surveyor " (London, 1653) on pp. 46 to 50. In his description of the methods of calculation to be used we see the beginnings of a decimal arithmetic : " Let it be required to know how many Feet are contained in five Chains, 32 Links. First set down your five Chains, 32 Links... as you see in the first Example, with a Comma between the Chains and Links. Then multiplying the five Chains, 32 Links by 66, the Product will be 35112, from which, cut off the two last Figures towards the Right-hand, with a Comma, then will the Number be 351,12 which is 351 Feet, and $\frac{12}{100}$ parts of a Foot, or 351 Feet, one Inch and a half; and so many Feet are contained in five Chains, 32 Links.

Example I	*Example II*
5,32	9,05
66	66
31 92	54 30
319 2	543 0
351,12	597,30

... if the number of Links be less than 10, as in the second Example it is 9 Chains, 5 Links, you must place a Cypher before the 5 Links..." Later, on page 247, the method of determining an area when the sides are given in Chains and Links gives rise to more extensive excursions into decimal arithmetic.

(2) So printed in the original.

A slightly later work by the same author, LEYBOURN—" Arithmetick, Vulgar, Decimal & Instrumental," London, 1657 contains a very clear and complete exposition of Decimals. He uses any of three notations for the decimal point, a comma on the line, a dot on the line, or a dot level with the centre of the digit. There is an interesting departure in the section on Instrumental Arithmetic. Scales graduated according to systems of money, weights, and measures are engraved on a page of the book, and alongside each scale is another one of equal length divided decimally and bearing the figures 0, 100, 200 etc. up to 1000. From these scales it is possible to read off what decimal fraction of the whole, any of the subdivisions of the money, weight, or measure scales may be. Thus one scale is graduated from 0 to 24 to represent the pence in two shillings (each penny is subdivided into 4 for farthings). The graduation for, say, six pence falls opposite 250 on the decimally divided scale, so that 6 pence is 0.250 of two shillings.

To summarize, the marking off of scale divisions in groups of ten appears to have antedated the invention of decimals, but the large graduations were numbered according to the total number of subdivisions present. The diagonal scale was used for subdividing into tenths in the middle of the 16th century; but only after the introduction of logarithmic scales in 1620 was it realized that the powers of ten could be omitted. By 1750, assuming that the collection in the Science Museum is a fair sample, it was commoner to subdivide an inch into ten parts than into any other submultiple such as eighths or twelfths.

(Science Museum, London, S.W. 7.) H. R. CALVERT.

The velocity of light

History of its determination from 1849 to 1933

In *Nature* (October 22nd, 1927, p. 602) the writer has given a complete Table of all the determinations of the velocity of light, made up to that date; appended to that Table is a short discussion of each determination. This work, which was quoted by Prof. A. A. MICHELSON in the Bibliography of the article "Velocity of Light" in the 14th edition of the Encyclopaedia Britannica, was the result of an exhaustive study of the original Memoirs, undertaken when it was discovered that no reliance whatever could be placed on the values given in many Papers dealing with the subject, and in any Table of Constants then available, owing to errors which vitiated them to an almost unbelievable extent. Reference to the original publications showed that several of the observers themselves had misquoted their own results, date, length of base, or even actual velocity, owing either to stating them from memory or to overlooked printer's slips. Successive writers of text books and compilers of Tables had copied these errors over and over again. Spurious determinations had arisen either from the rediscussion of the determinations of some observer by armchair critics or by the averaging (after arbitrary weighting) of several determinations obtained by different observers, and these spurious values have been sometimes inserted in Tables, without discrimination or explanation, thereby adding to the confusion. The chaos introduced by the liberties taken by compilers, combined with printer's slips and errors of copying, was revealed by a comparison of a Table of values of the velocity of light, given by Prof. A. A. MICHELSON in the *Journal of the Franklin Institute*, with the Table given in the "Recueil de Constantes Physiques" by ABRAHAM and SACERDOTE, published under the auspices of the Société Française de Physique : these

two statements, by such high authorities, are in disagreement in respect of every single determination mentioned in both! Both Tables, taken together, refer to eleven determinations; only one out of the eleven is given correctly; one of them is non-existent! The writer has dealt with these cases in *Nature* (*loc. cit.*) and in *Ciel et Terre* (1930, pp. 216 *et seq.*).

This truly deplorable state of affairs made it impossible to obtain a correct idea of the state of our knowledge respecting this fundamental so-called constant, although, in the mind of the writer, such a study had become imperative in view of certain peculiarities which had attracted his attention for some time; the result was the publication of the Table referred to. This Table has been reproduced in *Ciel et Terre* (1929, p. 190) and with slight modifications of form, in *Physikalische Zeitschrift* (1928, p. 166); it has now been brought up to date and is reproduced here, by kind permission of the Editor of *Nature*, as it is the only existing Table giving a correct and complete summary of the observations.

Compiled from the original Communications, Papers or Memoirs written by the physicists themselves who made the observations, it contains all the values which have seemed to them worthy of mention, as resulting from complete series of experiments obtained during the work which finally led to the value which, according to them, represented the best result of their efforts, and which final values have been printed in heavy type. Generally, the several values given have been left in the form given in the original publications, except that all the values have been expressed in kilometres per second. Even when a modification or a correction would have been justified, for example, when the velocity in air only was given, or when it was given with an accuracy which was evidently illusory, in view of the magnitude of the probable error, the writer has not taken any liberty and has faithfully transcribed the values given by their authors. Too often, the compiler of a Table of this kind thinks it necessary to introduce, in the results which he records, modifications which are more or less justified, but which render them unrecognizable. Also, averaging results obtained by different observers is a procedure absolutely unwarranted when these results show every indication that the quantity is not constant, and has been a fruitful source of

No.	Average date.	Investigator	Method.	Length of base.	Base.	Velocity, km./sec.	Medium	Remarks.
1	1849.5	Fizeau	TW	8,633 m.	Suresnes—Montmartre	315,300	Air	
2	1862.8	Foucault	RM	20 m.	Paris Observatory	298,000 ± 500	,,	
3	1872.0	Cornu (*a*)	TW	10,310 m.	École Polytechnique—Mont Valérien	298,500 ± 300	,,	Preliminary value (rejected as doubtful).
4	1874.8	,, (*b*)	,,	22,910 m.	Paris Observatory—Montlhéry	**300,400 ± 300**	Vac.	
5	,,	Cornu-Helmert	,,	,,	,,	**299,990 ± 200**	,,	Cornu's results discussed by Helmert.
6	1878.0	Michelson (*a*)	RM	1,986.23 ft.	U.S. Naval Academy	300,140 ± 300	,,	Preliminary value (discarded).
7	1879.5	,, (*b*)	,,	,,	,,	**299,910 ± 50**	,,	Corrected value.
8	1880.9	Newcomb (*a*)	,,	2,550.9 m.	Fort Meyer—U.S. Naval Observatory	299,627	Air	Doubtful.
9	1881.0	Young and Forbes	TW	{ 18,212.2 ft. and 16,835.0 ft. }	Wemyss Bay—Hills behind Innellan	} 301,382	Vac. {	Admittedly unreliable.
10	1881.7	Newcomb (*b*)	RM	3,721.2 m.	Fort Meyer—Washington Monument	299,694	Air	Doubtful.
11	1881.8	,, (*c*)	,,	—	—	299,810	Vac.	Mean of (*a*), (*b*), and (*d*).
12	1882.7	,, (*d*)	,,	3,721.2 m.	Fort Meyer—Washington Monument	**299,860 ± 30**	,,	Final declared value.
13	1882.8	Michelson (*c*)	,,	2,049.532 ft.	Case School of Applied Science, Cleveland	**299,853 ± 60**	,,	
14	1900.4	Perrotin (*a*)	TW	11,862.2 m.	Nice Observatory—La Gaude	299,900 ± 80	Vac.	Preliminary discussion (superseded).
15	1900.4	,, (*b*)	,,	,,	,,	300,032 ± 215	,,	Final discussion (discarded).
16	1901.4	,, (*c*)	,,	—	—	299,880 ± 50	,,	Mean of (*a*) and (*d*) (superseded).
17	1902.4	,, (*d*)	,,	45,950.7 m.	Nice Observatory—Mont Vinaigre	299,860 ± 80	,,	Preliminary discussion (superseded).
18	1902.4	,, (*e*)	,,	,,	,,	**299,901 ± 84**	,,	Perrotin's final declared value.
19	1924.6	Michelson (*d*)	RM	35,385.53 m.	Mt. Wilson Observatory—Mt. St. Antonio	**299,802 ± 30**	,,	Preliminary (corrected) value.
20	1926.0	,, (*e*)	,,	,,	,,	**299,796 ± 4**	,,	
21	1928.5	Karolus and Mittelstaedt	Kerr Cell	41,386 m.	Leipzig	**299,778 ± 20**	,,	Frequency of the order of a million.
22	1932.1	Pease and Pearson	RM	1 mile	Mt. Wilson Observatory	**299,774 ± 10**	,,	In a pipe line.

spurious values in Tables of Constants. Is it probably for this reason that, with the exception of the Table given above, there exists no Table of values of this so-called constant, the data in which truly represent the facts.

It has frequently been impossible to ascertain exactly the date of a series of observations, and, in this case, after careful examination of the original publications, a date has been adopted, which appears to represent the most likely position of the resulting value on the chronological scale. As the values of the velocity are given in the Table in order of dates, it follows that any average value, given by some observer, and to which an average date has been allotted, is placed in this Table before some of the determinations which have contributed to it. The dates are expressed by the use of a decimal which indicates approximately the place of the observations in the year mentioned. As will be seen later, these dates play a very important part in the history of the determinations of this pseudo-constant.

The methods by means of which the determinations of the velocity of light were made are based on two different principles embodied in the well-known toothed wheel method and revolving mirror method, respectively. Quite recently, an ingenious modification of the former method has been used by KAROLUS and MITTELSTAEDT : instead of a toothed wheel, a Kerr cell, at the terminals of which was applied an alternating difference of potential, was used to interrupt periodically the passage of a luminous beam the path of which passed through the transparent liquid dielectric of the cell, between the plates of the condenser (*Physikalische Zeitschrift*, 1928, pp. 698-702; 1929, pp. 165-167). The chief advantage of this method is that the frequency of the periodic interruption of the beam can be accurately calculated, which was not the case when the toothed wheel was used; moreover, a much higher frequency can be used with this method, of the order of a million per second, so that a correspondingly short base (in this case 41.386 metres) can be used while maintaining as high a standard of accuracy as was obtained over long bases with ordinary frequencies.

It has been suggested (*Nature*, October 22, 1927, p. 586) that the interruption of light by a quartz piezo-resonator excited to resonant vibration by an applied oscillating voltage from a valve

circuit, may be used successfully instead of a revolving toothed wheel or a Kerr cell, the frequency obtainable being ten million per second or more. This method, combined with the use of photo-electric methods for ascertaining the exact instant of minima, would raise the observational technique to its highest pitch. May the writer express the hope that it will be carried out in England, which so far has to its credit but a single attempt, admitted to be of little scientific value (N° 9 of the Table).

Already towards the end of last century, it was apparent that, excepting the determinations of FIZEAU and FOUCAULT, which one is justified in considering as being mere pioneer experiments for ascertaining the feasibility of the measurement of the velocity of light, all the values obtained up to then, by CORNU, MICHELSON and NEWCOMB, showed that the velocity of light was decreasing. A review of these determinations, in the " Rapports présentés au Congrès International de Physique de 1900 " (Vol. 2, p. 225) mentioned a rediscussion, by HELMERT, of CORNU's observations, giving 299,990 ± 200 km./sec. This confirmed the decrease of velocity, but it did more : if, in spite of CORNU's protest against the treatment his results had received in HELMERT's hands, we substitute the value calculated by the latter instead of CORNU's own original value, the four observations :

1874.8	CORNU - HELMERT	299,990 km./sec.
1879.5	MICHELSON	299,910 » »
1882.7	NEWCOMB	299,860 » »
1882.8	MICHELSON	299,853 » »

when plotted, are found to be on a straight line with a practically absolute accuracy, showing that the decrease follows a linear law of variation the equation of which, obtained by CAUCHY's method (*The Engineer*, 13th September 1912) is :

$$V = 331291.65 - 16.6964\ T$$

where V is the velocity of light in kilometers per second and T is the time in years.

To those physicists who attach some significance to the fact, it may be pointed out that the probable errors of the observations are greater than the amplitude of the variation.

The writer has never attributed to the Theory of Errors more importance than it deserves, and, in his opinion, the perfect linear agreement of these four values constitutes an unimpeachable

evidence that, during the last quarter of the last century, the velocity of light has been decreasing according to a linear law.

The publication of PERROTIN's results (N^{os} 14, 16 and 17 of the Table) in the *Comptes Rendus* in 1900 and 1902, however, threw doubt on the above conclusions, as well as providing erroneous data which vitiated all the Tables of this pseudo-constant published subsequently, which quoted the results given in the *Comptes Rendus*, and overlooked the final discussion given in the *Annales de l'Observatoire de Nice* (1908), which is the only publication to give PERROTIN's correct value : 299,901. The question perforce remained in abeyance until 1925, when Prof. MICHELSON's new result 299,802 (N° 19 of the Table) was made known. The writer could not fail to notice that, whatever might have been the behaviour of the pseudo-constant in the interval 1883-1902, it had resumed its decrease :

1902.4 PERROTIN 299,901 ± 84.
1924.6 MICHELSON 299,802 ± 30.

the variation being 99 km./sec. in 22.2 years, or 4.46 km./sec. per year.

(It is to be noticed that, this time, the amplitude of the variation is distinctly greater than the probable errors).

The writer was so convinced of the truth of his deduction, that on the 20th December 1924 he wrote to the Editor of *Nature* and, on the 23rd January 1925 he wrote to Monsieur E. TOUCHET, of the Société Astronomique de France, definitely calling attention to the fact that the velocity of light was varying, and, to the latter, he predicted that the next determination, which Prof. MICHELSON was even then occupied in obtaining, would yield a still lower result, and he even gave beforehand a forecast of its value : 299,792. The value found by Professor MICHELSON was actually 299,796 ± 4 (N° 20 in the Table). It occupied a position on the graph in good alignment with the two others.

If we assume that the observations made on short bases are not so trustworthy as those made on very long bases, and take into consideration these latter alone, the four observations :

1874.8 CORNU - HELMERT 299,990 km./sec.
1902.4 PERROTIN 299,901 » »
1924.6 MICHELSON 299,802 » »
1926.0 MICHELSON 299,796 » »

give a linear law

$$V = 307{,}480.98 - 3.99\ T$$

implying a decrease of 4 km./sec. per year, which represents these observations fairly well. If we only take into consideration the observations made during this century up to that date, the law is not very different

$$V = 308{,}376.22 - 4.455\ T$$

the agreement between the observations being almost perfect.

In 1927, the writer endeavoured to stir up scientific interest in this remarkable behaviour of the most fundamental of the physical "constants" (*Astronomische Nachrichten*, N° 5520) and, discussing the available evidence, he arrived at the definite conclusion that the velocity of light was not a constant, and considered the two alternative possibilities : a continuous decrease or a periodical variation (*loc. cit.* and *L'Astronomie*, November 1927, p. 504). It is, in fact, in order to be able to treat mathematically the observations available so as to investigate the law of variation that the writer made the preliminary clearing of the ground that resulted in the Table.

Two more determinations have been made since, and each one is lower than the one before, and may be taken as belonging to the alignment of the prior determinations made during this century.

The persistently decreasing numerical values yielded by the observations, however, are not by any means the only evidence that the velocity of light has been, and is actually, decreasing; secondary considerations strongly support this deduction; the decrease has impressed its stamp even on the preliminary determinations, rejected by their authors in favour of the values they adopted as final, because, in their estimation, those were more accurate. These secondary considerations are as follows :

a) Two pairs of observations were made at times which were very close to each other : they are (12)-(13) and (19)-(20) of the Table; they are the only observations which gave almost identical results. The time interval being short the variation was very small; nevertheless, in each pair, ***the earlier observations give a higher velocity***.

b) PERROTIN has made two determinations (14) and (17). He has given the same weight to these two determinations. The *later* velocity is the ***smaller***.

c) Two preliminary determinations have been rejected because their probable error was greater than that of the final value obtained. They are (6) and (15). In both cases, they were made *earlier* than the final results, and they give *greater* values.

d) The group of determinations, (3), (8) and (10) have been rejected by their authors because they considered them as being affected by important systematic errors. In every case these results are *smaller* than those obtained subsequently. In other words, *the only determinations which were against a decrease of velocity are precisely those which their authors declared to be doubtful owing to systematic errors* !

All these circumstances cannot be fortuitous. There must be an unexplained cause which brings about the fact that, *without a single exception*, the earlier determinations always yield a greater velocity, *unless they are affected by serious systematic errors*. This cause, whatever its nature may be, makes itself felt in the whole range of the observations although its effect is attenuated by probable errors greater than itself, but which, however, cannot succeed in obliterating its effect. It is not possible to admit that all the coincidences pointed out are accidental. The only plausible explanation is that the velocity of light was decreasing during the last century, and is decreasing at the present time.

The evidence for a variation (decrease) of the velocity of light may be summed up as follows :

Nature of evidence	*Number of elements of evidence*
4 decreasing observations (period 1874-1883) :	6
5 decreasing observations (period 1902-1934) :	10
2 pairs of nearly simultaneous observations in close agreement :	2
A very good linear distribution between 1874 and 1883 :	1
A fairly good linear distribution between 1902 and 1934 :	1
Decreasing order of two preliminary observations of same weight :	1
Decreasing order of two rejected observations :	1
Doubtful character of the only three observations against :	3
Total :	25

That is to say 25 elements of evidence in favour of, and none

against, the deduction that light has decreased during the two periods considered.

The unanimous character of this evidence cannot be due to chance; it is this striking agreement that led the writer to believe that, notwithstanding their sometimes relatively large probable errors, the observations had, on the whole, an unexpectedly high degree of accuracy, which even their authors did not suspect, (and which the Theory of Errors certainly lamentably failed to put in evidence), and caused him to affirm that the velocity of light was either continuously decreasing or varying periodically (*Astronomische Nachrichten*, September 1927, N° 5520, p. 450; *L'Astronomie*, November 1927, pp. 504 *et seq.*).

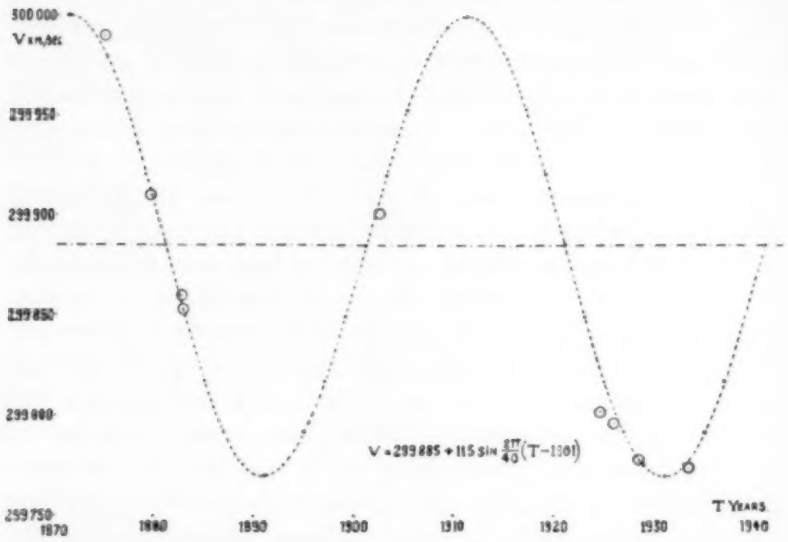
If this decrease is admitted, we have to face an alternative : either PERROTIN's value of 299,901 in 1902.4 is substantially correct, and in that case the velocity of light has increased during a part or the whole of the interval 1883-1902, or it is not accurate (it has a rather large probable error). Unfortunately it is the only determination made during a period of about 40 years, precisely when their presence is most necessary to settle the question.

There is one consideration which can decide which of the two deductions is the most likely to be correct : it is of course easy to draw an irregular curve through the points representing the observations, as they stand, but the writer submits that this is the last thing which should be resorted to. The more we study natural laws, the more we unravel their complexity, the more we see that this complexity is only apparent, and that simplicity and regularity are the keynotes of the *modus operandi* of the creation. Given that the velocity of light varies, it can be surmised *a priori* that the law of variation is simple. If, therefore, other things being equal, that is to say, the agreement or otherwise of all the observations with any suggested law of variation being equally good, the simplest solution should be the most probable, whether of the periodic or of the continuous type. The writer therefore welcomed the suggestion made by MR. F. K. EDMONDSON, in a letter dated April 14, 1934, that a simple sine curve the formula of which is

$$V = 299{,}885 + 115 \sin \frac{2\pi}{40} (T - 1901)$$

represented the observations remarkably well.

The figure shows how this curve answers the case; it must be admitted that the agreement is so remarkable as to leave little doubt in one's mind that it is the correct law of variation. The period is 40 years. The greatest deviation is that of MICHELSON's 1924.6 result. The curve gives 299,823 as compared with the observed value of 299,802. The other deviations are all under



10 km./sec. By 1941 the periodic curve will have attained the value 299 885, whereas a linear decrease would make the value 299 735. The question will therefore be finally settled within the next decade. By 1940, the departure from the present value should be greater than observational errors whether the variation be periodic or linear. " The fact that a double periodical variation of the velocity of light has been discovered by the observers at Mount Wilson (amplitude about 20 km./sec. and periods $14\frac{3}{4}$ days and 1 year, respectively) disposes of any *a priori* objection to a variation of velocity of the kind referred to." Mr. EDMONDSON has further pointed out to the writer that the logarithms of the observations over long base lines are well represented by a straight line. This gets rid of the mathematical difficulty of the velocity becoming zero in a finite length of time. Furthermore, such a relation is required by the theory if we attribute the apparent decrease to a variation of the unit of length (i.e. an expanding

universe). If the radius of the universe doubles every K years, then the velocity of light (measured) will be halved every K years, that is, the velocity will be proportional to $(\frac{1}{2})^t$. Thus, the logarithm of the velocity must be a linear function of the time.

Whatever the result, however, the constancy of the velocity of light has proved to be but a working hypothesis which must now make way for a new theory more in agreement with the facts.

What this theory will be is beyond both the scope of this Paper and the ability of the writer.

London M. E. J. GHEURY DE BRAY

BIBLIOGRAPHY

(Publications in which erroneous statements or misleading misprints are to be found are indicated by an asterisk).

FIZEAU. *Comptes rendus des Séances de l'Académie des Sciences*, Paris: Vol. 29, 1849, p. 90.

FOUCAULT. *Comptes Rendus* : Vol. 55, 1862, p. 501 and p. 792.

CORNU. *Comptes Rendus* : Vol. 79, 1874, p. 1361.

CORNU. *Annales de l'Observatoire de Paris* : Vol. 13, 1876.

HELMERT. *Astronomische Nachrichten* : Vol. 87, N° 2072, 1876, p. 123.

FOUCAULT. *Recueil des Travaux Scientifiques de Léon Foucault*, 1878.

MICHELSON. *Proceedings of the American Association for the Advancement of Science* : 1879, p. 124.

TODD*. *American Journal of Science* : 3rd. Series, Vol. 19, 1880.

MICHELSON. *Astronomical Papers of American Ephemeris* : Vol. 1, Part. 3, p. 109.

RAYLEIGH. *Nature* : 25 August 1881, p. 382 and 17 November 1881, p. 52.

NEWCOMB*. *Astronomical Papers* : Vol. 2, Part 3, p. 107.

MICHELSON. *Astronomical Papers* : Vol. 2, Part 4, p. 231.

YOUNG and FORBES. *Philosophical Transactions* : Vol. 173, Part. 1, 1882, p. 231.

HARKNESS*. *Washington Observations for* 1885 App. III, p. 29.

SCHUSTER. *Nature* : 11 March 1886, p. 439.

CORNU*. *Rapports Présentés au Congrès International de Physique* : 1900, Vol. 2, p. 225.

PERROTIN*. *Comptes Rendus* : Vol. 131, 1900, p. 731 and Vol. 135, 1902, p. 881.

PERROTIN. *Annales de l'Observatoire de Nice* : Vol. 11, 1908.

MICHELSON*. *Decennial Publications of the University of Chicago* : Vol. 9, 1902, p. 6.

MICHELSON*. *Philosophical Magazine* : 6th Series, Vol, 3. p. 334, 1902 and Vol. 8, p. 716, 1904.

WIEN. *Physikalische Zeitschrift*, 1904, p. 585.

MICHELSON. *Astrophysical Journal* : Vol. 60, 1924, p. 256 and Vol. 65, 1927, p. 1.

MICHELSON*. *Journal of the Franklin Institute* : November 1924, p. 627.

MICHELSON*. *Nature* : 6 December, 1924, p. 831.

BOWIE. *Astrophysical Journal* : Vol. 65, 1926, p. 14; *Carnegie Institution of Washington (Contributions from the Mount Wilson Observatory)* : Vol. 15, 1926-27, p. 48.

MICHELSON. *Astrophysical Journal* : Vol. 37, 1912, p. 196; Vol. 61, 1924, p. 137 and p. 140; *Carnegie Institution of Washington (Contributions from the Mount Wilson Observatory)* : Vol. 15, 1926-27, p. 35.

GHEURY DE BRAY. *L'Astronomie* : March 1926, p. 113 : Augst 1927, p. 380; November 1927, p. 504; January 1928, p. 49; *Nature* : 17 September 1927, p. 404; 22 October 1927, p. 594 and p 602; *Astronomische Nachrichten* : N° 5520, September 1927, p. 450; N° 6038, June 1934, p. 236.

GRANT. *Nature* : 22 October 1927, p. 586.

MICHELSON. *Studies in Optics*, 1927.

GHEURY DE BRAY. *Ciel et Terre* : 1927, pp. 203, 222; 1928, pp. 23, 107, 202, 403; 1929, pp. 3, 82, 187; 1930, p. 216; 1931, p. 110.

MITTELSTAEDT. *Inaugural Dissertation (Leipzig Bibliographisches Institut A. G.)*, 1928.

PRESTON. *The Theory of Light* : Chap. XIX (5th Ed., 1928).

KAROLUS and MITTELSTAEDT. *Physikalische Zeitschrift* : XXIX, 1928, p. 698.

ENCYCLOPAEDIA BRITANNICA : *Velocity of Light* (14 th Ed., 1929).

MITTELSTAEDT. *Annalen der Physik* : Vol. 2, 1929, p. 285.

MITTELSTAEDT. *Physikalische Zeitschrift* : XXX, 1929, p. 165.

VRKLJAN. *Zeitschrift für Physik* : Vol. 63, 1930, p. 688.

VRKLJAN. *Nature* : 13 June 1931, p. 892; 15 August 1931, p. 269.

GHEURY DE BRAY. *Nature* : 4 April 1931, p. 522; 16 May 1931, p. 739; 13 June 1931, p. 892*; 16 April 1932, p. 573; 24 March 1934, p. 464; 23 June 1934, p. 948.

WILSON. *Nature* : 2 July 1932, p. 25.

KENNEDY. *Nature* : 20 August 1932, p. 277.

MASON. *Nature* : 15 July 1933, p. 100.

PEASE and PEARSON. *Nature* : 3 February 1934, p. 169.

EDMONDSON. *Nature* : 19 May 1934, p. 759; *Publications of the Astronomical Society of the Pacific* : Vol. 46, N° 271, June 1934.

BIRDGE. *Nature* : 17 November 1934, p. 772.

DIRECTORS of Mount Wilson Observatory : *Reports. Year Book of the Carnegie Institution of Washington* : 1920, p. 253; 1921, p. 281; 1922, p. 242; 1923, p. 211; 1924, p. 110; 1925, p. 122; 1925-26, p. 134; 1926,-27 p. 134; 1927-28, p. 149; 1928-29, p. 142; 1929-30, p. 179; 1930-31, p. 218; 1931-32, p. 170; 1932-33, p. 164; 1933-34, p. 156.

MICHELSON, PEASE & PEARSON. *Astrophysical Journal :* Vol. 82, July 1935, p. 26.

Notes and Correspondence

Answer to Query no. 46.—"Sleeping along the meridian." *Isis* 22, 1935, p. 525 ff.).

Dr. SARTON expressed his conviction that the widespread popular belief must go back to older sources, and he is right about that. One such source I find in the Talmud, *Berakhot 5b*. Though the authorities quoted lived *c.* 200-300 A.D., it is obvious that they simply refer to an ancient tradition of the native Palestinian-Babylonian folklore. The text reads : " One Baraita says : ABBA BENJAMIN says : As long as I live I took great pains about two things : That my prayer shall be before my bed, and that my bed shall be placed between North and South (1) ... Similarly, said RABBI HAMA the son of R. HANINA in the name of R. ISAAC : Whoever places his bed between North and South, has male children... RAB NAHMAN the son of ISAAC says : Neither does his wife miscarry."

RASHI and tosafot (c. 1100-1200) bring the curious gloss that the *Shekhinah*, or Divine Grace, rests in the direction of East-West. A man should therefore not lie in the same direction with his wife. The rule however, was codified as a general religious prescription, for married and unmarried people alike, to sleep only in the direction of head North and feet South. LIPMANN HELLER (2) (1579-1654), in his *Ma'adanei Hamudot*, *ad locum*, says that he found it in the books of the natural scientists that the North wind is conducive, or favorable, to the birth of male children.

SOLOMON GANDZ.

Réponse à la question 50.—Apropos de la soie d'araignée et des traductions chinoises (*Isis* 24, 103-6, 1935).

Au sujet de la traduction chinoise ou mandchoue du mémoire sur le *tissage du fil d'araignée*, je n'ai encore trouvé qu'un renseignement nouveau et, me semble-t-il, erroné. M. FOURNIER (*Voyageurs naturalistes du clergé français avant la Révolution*. Paris, p. 44) laisserait

(1) As the commentators rightly say : head North and feet South.

(2) Chief Rabbi of Prague and Cracow, distinguished also through his secular studies.

supposer que ce ne fut pas le P. PARRENIN, mais le P. d'ENTRECOLLES qui « aurait traduit en mandchou la dissertation alors fameuse de BON DE SAINT HILAIRE » : aucun argument ne paraît motiver cette affirmation (Comparer la notice du P. d'ENTRECOLLES par le P. PFISTER. *Notices biographiques et bibliographiques sur les jésuites de l'ancienne mission de Chine*. Chang-hai. 1932-4, p. 539-549, n° 242).

Par contre, sur la *traduction mandchoue*, par le P. PARRENIN (et non PARENNIN, comme on l'écrit souvent), du *traité d'anatomie* d'après BARTHOLIN et DIONIS, M. J. W. JOHNSON a écrit un long article : L'anatomie mandchoue et les figures de TH. BARTHOLIN. Étude d'Iconographie comparée, dans *Det Kgl. Danske Videnskabernes Selskab Biologiske Meddelelser*, VII, 7. Copenhague, 1928.

Le manuscrit de cette anatomie mandchoue était signalé en deux copies par CORDIER (Bibliotheca Sinica. Seconde édition, col. 3672) : l'une au Museum d'histoire nautrelle de Paris. Cat. des manuscrits. no. 2009 en 8 fascicules; l'autre donnée à la Bibliothèque royale de Copenhague en 1906. C'est ce dernier exemplaire qui a été édité par VICTOR MADSEN en 1928 à Copenhague (en facsimile, voir *Isis* 12, 161) M. PELLIOT dans le *T'oung Pao*, t. 26, 1929, p. 404 dit qu'il possède, lui aussi, un manuscrit de cette anatomie in-8° dont le texte est beaucoup plus détaillé. J'ai vu un de ces facsimilés à la Bibliothèque nationale de Pékin.

Je crois avoir retrouvé le livre original, malheureusement fort mutilé, d'où le P. PARRENIN a extrait ces gravures; j'en collationnerai plus tard les figures avec celles du facsimilé.

Il peut être bon de reproduire le texte du P. PFISTER (p. 513), écourté ou mutilé dans la traduction anglaise de WONG et WEI (on paraît croire que le mandchou est la même chose que le « mandarin » : ce dernier n'est autre que la langue chinoise des lettres).

« 3. L'*Anatomie de l'homme* suivant la circulation du sang et les nouvelles découvertes, par DIENIS (sic ! DIONIS), traduite en mandchoue. Cette traduction, en 8 vol., commencée par le P. BOUVET (ci-dessus, p. 434), revue par K'ANG-HI lui-même, n'a pas été imprimée. Le P. PARRENIN y ajouta un 9e volume, également en tartare-mandchou, sur la chimie et ses principes, l'action des poisons et la lenteur des remèdes. Il mit cinq années à composer cet ouvrage, parce qu'il était toujours occupé à la suite de l'empereur. Une copie MS. de l'Anatomie se trouve chez le Dr. DUDGEON, à Pékin; elle contient des planches très bien exécutées. Une autre copie est à la bibliothèque de la Légation russe à Pékin (BRETSCHNEIDER, Botanicon Sinicum, p. 102) (Serait-ce une de ces copies qui aurait abouti à Copenhague ?).

« Le P. PARRENIN, en envoyant sa traduction à MM. de l'Académie,

leur écrivait : « Messieurs, vous serez peut-être surpris que je vous envoie de si loin un traité d'anatomie dans une langue qui, sans doute, vous est inconnue. Mais votre surprise cessera quand vous saurez que ce sont vos propres ouvrages que je vous envoie habillés à la tartare. Oui, Messieurs, ce sont vos pensées et vos ingénieuses découvertes » (Lettres dif., t. III, p. 330).

« Il faut, dit M. DE CHATEAUBRIAND, lire d'un bout à l'autre cette lettre, où respirent un ton de politesse et ce style des honnêtes gens, presque oubliés de nos jours ».

(Hautes études, Tientsin, Chine.)

Ningtsing, 14 décembre 1935.

HENRI BERNARD, S. J.

Answer to Query no. 53.—"Standing on the shoulders of giants" (*Isis* 24, 107-09).

This expression, which JOHN OF SALISBURY ascribes to BERNARD OF CHARTRES, is also found in the *De naturis rerum* of ALEXANDER NECKAM, written between 1150 and 1200 (1) : " Et, ut ait philosophus, nos sumus quasi nani stantes super humeros gigantium." (ed. T. WRIGHT, London, 1863, p. 123). This is perhaps a reference to BERNARD OF CHARTRES. A similar expression is said to have been made by PETER OF BLOIS, c. 1180 (BÉDIER and HAZARD, *Histoire de la littérature française*, Paris, 1923-24, vol. 1, p. 15). I have not been able to verify this statement.

The same belief in the progress of science is very well expressed by the French surgeon GUY DE CHAULIAC in his *Prologue* to *La grande chirurgie* (written c. 1363) : " Car les sciences sont faites par additions, n'estant possible qu'vn mesme commence, et acheue. Nous sommes comme enfans au col d'vn geant : car nous pouuons voir tout ce que voit le geant, et quelque peu dauantage" (ed. E. NICAISE, Paris, 1890, p. 4). Owing to the great popularity of this work in France during the fifteenth and sixteenth centuries, the phrase doubtless became well-known to French medical writers. Thus it is found in the *Traicté et response de* ALEXANDRE DIONYSE *Maistre chirurgien & barbier à Vendosme* (Paris, 1581), and in FRANÇOIS MARTEL's *Apologie pour les chirurgiens* (Lyon, 1601).

An early example of the expression in English occurs in a little tract entitled *Outlandish proverbs*, compiled by the poet GEORGE HERBERT (1593-1633), but not published until 1640. Proverb 50 of this collection runs : " A Dwarfe, on a Gyants shoulder, sees further of the two." Among later writers who have used the expression may be mentioned

(1) For an account of ALEXANDER NECKAM, see G. SARTON, *Introduction*, vol. 2, p. 385-86.

the poet and philosopher SAMUEL TAYLOR COLERIDGE (1772-1834) : " A dwarf sees farther than the giant when he has the giant's shoulder to mount on " (*The Friend*, Sec. 1, Essay 8).

(London.) R. E. OCKENDEN.

Query no. 61.—The dates of birth and death of Johannes Scultetus (1595-1645?).

An interesting question has been raised by Dr. SARTON as to the exact dates of the well-known writer on surgery of the seventeenth century,

JOHANNIS SCULTETI
Phil. & Med. Doctoris inclutæ
Reip. Noribergenſi: Phyſici Ordin.

PROPHYLAXIS
Circa Præſentem & Futurum
Sanitatis Statum

ORATIONE
Propoſita
In Publico ad D. Ægidium
Auditorio

NORIBERGÆ,
Typis Michaëlis Endteri,
A. R. S.
M. DC. LXV.

JOHANNES SCULTETUS or SCHULTES. Not having access to a great medical library, one takes it for granted that BASS and HAESER and GARRISON and SUDHOFF were probably correct in saying that SCULTETUS was born in Ulm Germany in 1595 and died in 1645, and that he was the son of

a ship master and lived most of his life in Nuremberg. As a boy he had to work for his education and managed to get to Padua where many great men studied medicine in the seventeenth century. Whether he preferred surgery to medicine, and how he came to write the best book on surgery of the time, illustrated by himself with forty-six woodcuts, showing not only instruments but operations, none of these authors has said. His book was called *Armamentarium chirurgicum*, and it seems

to have been published in 1645, the alleged year of his death at the age of fifty. The book was often republished in other languages than his own German or Latin. French editions came out in Lyons in 1672 and 1675, fully illustrated, and containing in addition the picture of a human monster. Evidently SCULTETUS was an artist of no mean talent, as may be seen from the accompanying reproduction of a phlebotomy scene in which a lambs' blood is being actually piped into the veins of a man, while from the opposite arm of the man his own blood is pouring into a bowl. We can but wonder therefore, if the artist was also the surgeon.

Moreover, was this SCULTETUS the same as he who wrote a little book on the prophylaxis of disease and delivered it as a grand oration before the distinguished men of the senate and faculty in Nuremberg on March 19, 1665, in the great auditorium of the Gymnasium, apparently twenty years after he was supposed to be dead? Or was this little book printed so late because it had been overlooked during the Thirty Years' Wars, as happened with his surgery, republished in the seventies in France?

The volume on prophylaxis is only five by three inches, containing sixty-two pages of less than one hundred words to a page, addressed to the "*Illustris senatus Norumbergensis, duum viris, septemviris, dominis et patronis meis magnis, summa observantia colendis.*" It may have been written in order to be delivered with much pomp because of an epidemic of the plague which often raged during the seventeenth century. Why a surgeon was invited to give an important oration on prophylaxis we do not know, but we may infer that it was because this SCULTETUS had theories on the subject that were new to the learned citizens of Nuremberg. In florid Latin he states his opinion that plague, smallpox, leprosy, etc., are carried in the wind or dust from country to country, and that their seeds are accompanied by hosts of insects which, he adds, may also be one of the means of spreading contagion.

SCULTETUS scorns the use of charms and hocus pocus, urges his hearers to move to a healthful climate where they may live out of doors, drink the purest of water, eat simple foods, and in fact, lead a simple life. He gives half praise to two medicinal remedies often used by the physicians of his time to counteract contagion, the *Elixir proprietatis* of PARACELSUS, and arsenic.

These scattered facts bring us back to our original question; was there only one SCULTETUS, or were there two or three of that name in two generations, or were some of his writings published posthumously in Germany as well as in France? These are questions for a historian who has access to a great library and time for research.

Haddam, Conn., KATE C. H. MEAD.
Dec. 28, 1935.

A biography of JOHANNES SCULTETUS and a bibliography of his published and unpublished (?) writings are very desirable indeed.

The Editor.

Query no. 62.—Joannes Gazulus.

In the list of works which REGIOMONTANUS proposed to edit, compose and publish, as given in MS Vatican Palatine Latin 1375, fol. 176*v*

—which I at present follow—and elsewhere, occurs the following item : " De distinctione domiciliorum celi contra CAMPANUM et JOANNEM GAZULUM " (i.e. On distinguishing astrological houses against CAMPANUS and JOHN GAZULUS). Can any reader of *Isis* supply further details concerning this JOANNES GAZULUS?

Columbia University, New York. LYNN THORNDIKE.

Query no. 63.—Early editions of the Deutsche Sphaera of Conrad of Megenberg.

A short time before 1342 CONRAD OF MEGENBERG translated into his Bavarian dialect the *Sphaera mundi* of SACROBOSCO. CONRAD's work, the *Deutsche Sphaera*, the earliest astronomical textbook in German, was edited in 1912 by OTTO MATTHAEI in the collection " Deutsche Texte des Mittelalters " published by the Prussian Academy of sciences. MATTHAEI discusses the manuscript sources; there are only three MSS. which he duly used, but he makes no reference to the early editions.

FRANZ PFEIFFER, in his edition of CONRAD's *Buch der Natur* (Stuttgart, 1861, p. IX, XXI) refers to JOS. DIEMER's *Kleine Beiträge zur älteren deutschen Sprache und Literatur* (1, 60-76, Wien, 1851) according to which the *Deutsche Sphaera* was first printed—without mention of CONRAD's name—by KONRAD HAINFOGEL in Nürnberg 1516. The same text was reprinted in Cologne 1519, Strassburg 1533, 1539. DIEMER's paper is not available to me, nor any of those early editions.

My queries : Are those early editions of the *Deutsche Sphaera* truly identical with the text edited by MATTHAEI? Do they actually represent CONRAD's version? If not, what are the differences? A description of those early editions with facsimiles of the title pages would be welcome.

GEORGE SARTON.

Query no. 64.—Ibn Shabbath, a thirteenth century engineer?

In NORMAN DOUGLAS' beautiful book entitled *Fountains in the sand. Rambles among the oases of Tunisia* (New York, 1912, p. 231-2), I came across the following statement concerning the gardens of Nefta :

" The ground is cultivated with mathematical parsimoniousness and divided into squares which made me think of the Roman *agrimensores*. But concerning this point, a civilized old native told me the following legend. Long ago, he said, these oases were wild jungles, and the few human creatures who lived near them little better than beasts. Then came a wise man who cut up and ploughed the watery district of Gafsa, Tozeur and Nefta; he planted trees and all the other growths useful to mankind; he divided the land into patches, led the water through them, and apportioned them among certain families—in short, he gave

these oases their present shape, and did his work so well that up to this day no one has been able to suggest any improvements or to quarrel with his arrangement. The story interested me; it may be a variant of the old Hercules myth—it shows how much the Arabs, with their veneration for past heroes and prophets, and their sterile distrust in the possibility of any kind of progress, will believe."

And he adds the footnote :

" It shows, also, that one cannot be too careful what one writes. I will take this little credit to myself, that, unconvinced of my own explanation, I made further enquiries and learned that—allowing for the inevitable exaggeration—the man actually existed ! His name was IBN SHABBATH; he was a kind of engineertopographer who lived about the thirteenth century; he wrote a commentary, in three volumes, on some well-known Arabic geographical poem—a commentary which exists only in a few manuscript copies, one of which is preserved at the Grand Mosque in Tunis, and another, I am told, in the library of Monsieur de FLEURY."

Who was this IBN SHABBATH ? I could find no trace of him in BROCKELMANN, or in B. ROY : *Extrait du Catalogue des manuscrits... de la grande mosquée de Tunis. Histoire* (Tunis, 1900), the only part of that catalogue available to me, or in PIERRE BODEREAU : *La Capsa ancienne et la Gafsa moderne* (Paris, 1907), a work done with considerable care but alas ! without index. Tunisian chronicles, which I have no time to investigate, might solve the problem.

GEORGE SARTON.

Medical history and deontology in Istanbul.—It is interesting to note that the professor of medical history in the University of Istanbul, Dr. A. SÜHEYL ÜNVER is officially called " tib tarihi ve deontoloji doçenti," i.e., docent of the history and deontology of medicine. This combination is a novelty to me, and in my opinion a very happy one. Instructors in charge of the history of medicine (as well as those in charge of other historical courses in scientific departments) are the natural expositors of all the ethical and humanistic questions concerning that discipline and that profession. Medical deontology derives a good part of its strength and nobility from the very traditions which it is the historian's peculiar duty to explain. However the best title in my opinion would be " professor of medical history and humanism," or " professor of medical humanism," for humanism implies tradition, that is, history. G. S.

The History of Biology Course at Brooklyn College.—Modern biology is so extensive and so complex, both in its contemporary ramifications and in its historical origins that a program planned for one

semester of thirty sessions can be only introductory. This is true even when, as at Brooklyn College, at least four terms of college biology are demanded as prerequisite. At this institution, the course is planned to place upon the student the responsibility for three main lines of study.

I. — Orientation in modern biology. An introductory survey of the diversity and relationships of biological work today. The subject matter includes the following :

(1) The assembling and classification of all types of studies and courses that are definitely biological in character, or in which biological principles are fundamental. The list prepared this term included over ninety separate fields, classified broadly as " general biology," " botany,", " zoology", " anthropology", " medicine", " applied biology", and collateral subjects.

(2) Survey and analysis of recent developments in biology. The outline of 1935 developments, presented by Science Survey (*Science*, Jan. 3, 1936) is being used as a basis for this analysis.

(3) Leading biologists of today and of recent times.

II. — Origins and development of modern biology. A chronological survey of the stages in the development of biology; including contributory streams and influences. In scope this part of the course follows the texts of SINGER and NORDENSKIÖLD.

Such general reference work is supplemented by outlines of special fields, like that for embryology in RICHARDS', " Comparative embryology " (WILEY), and by contributions of other members of the biology department at Brooklyn relating to their special fields.

III. — Individual reference work. Each member of the class is assigned some particular field of interest for intensive reference work throughout the term. This term, the first report related to a modern worker. A brief summary sketch, covering life, lines of work and bibliography was called for. One or two short additional reports are scheduled, dealing with earlier workers, with the purpose of making the students familiar with the very different viewpoints of earlier periods. Finally, a longer term report, covering the development of the particular biological field in which the student is interested, is called for.

This reference work takes the student into the research libraries of the city. For this purpose, bibliographies covering the general history of science titles in several large libraries have been prepared with the help of N. Y. A. student workers. So far, these bibliographies comprise the main Public Library of Brooklyn, 250 titles, the Brooklyn Botanical Garden Library, 300 titles, the N. Y. Academy of Medicine Library, ca. 800 titles. These lists definitely omit incunabula and more recent

source books. Students are expected to find such references by themselves.

(Brooklyn College.) RALPH C. BENEDICT.

The Crummer Room for the History of Medicine at the University of California Medical School, San Francisco.

With the help of Mrs. MYRTLE CRUMMER INGRAM, the University of California Medical School has opened a special library reading room for the history of medicine to be known as the Crummer Room in honor of the late Dr. LE ROY CRUMMER (1878-1934), formerly professor of the history of medicine at the University of California Medical School. The room contains about thirty-five hundred catalogued items relating broadly to the history of science and to the history of medicine in particular. It is open daily following the luncheon hour in order to facilitate browsing and reading on the part of staff and students. Informal seminars are held at biweekly intervals in the evenings on which occasions the resources of the room are used for illustrative purposes. In order to permit ready contact with the historical sources of modern medicine, the room is arranged as a lounge with easy chairs but with adequate facilities for study and research. A special collection, chiefly composed of gifts from Dr. CRUMMER relates to the classics of medicine and includes some one thousand items dating from 1472 to the present. This collection also includes many valuable and unpublished manuscripts. There is a special collection of about two thousand prints and pictures illustrating various phases of the history of science and medicine. There is also a special instrument collection consisting of surgical and medical instruments dating from the 17th century, a unique collection of ophthalmoscopes and a good group of early microscopes. The room contains, of course, the standard bibliographical and reference monographs and periodicals relating to the history of medicine. Ready availability of this material to staff and student body has resulted in a remarkable interest and use of the facilities of the room. A natural feature of the room is the special case reserved for contributions of California to medicine. C. D. L.

Society for the study of alchemy and early chemistry. A society for the study of alchemy and early chemistry has been founded in London. It is intended to place the study of alchemy and early chemistry on a broad basis, and for this reason the Council of the Society is desirous of securing the co-operation of scholars in various countries who will contribute to the interests of the Society. It is proposed to hold regular meetings, beginning early in 1936, at which papers will

be read and discussed, and to publish a journal in which accounts of the papers will be given as well as special articles, written contributions by members of the Society and reviews of books. The following council has been elected : Prof. J. R. PARTINGTON *(chairman)*, Dr. F. SHERWOOD TAYLOR *(Editor of the Journal)*, GERARD HEYM *(Hon. Secretary)*, K. DE B. CODRINGTON, L. F. GILBERT, Prof. S. R. K. GLANVILLE, Sir RICHARD GREGORY, Dr. E. J. HOLMYARD, Dr. D. MCKIE, Dr. L. W. G. MALCOLM, Dr. STEPHEN MIALL. Further information can be obtained from the Hon. Secretary, Society for the Study of alchemy and early chemistry, 8 Bream's Buildings, Fetter Lane, London, E.C.4. (From *Nature* 136, 1024, 1935).

Medicine and art.—The University of California Medical School announces a public showing of water color sketches and photographic montages attempting artistically to portray modern scientific activities relating to medicine. This exhibit has been arranged to celebrate the completion of the mural decorations by BARNARD ZAKHEIM in Cole Hall, which were made possible by the SERA and the WPA. Exhibit in the Pharmacological Laboratory, Medical School Building (on the same floor as the murals in Cole Hall). 1 to 5 daily, from Sunday, February 16, to and including, Sunday, February 23, 1936.

Die Entdeckung des Milchzuckers.—Auf S. 367 des 24. Bandes der *Isis* erwähnt Herr M. NIERENSTEIN unter den Schriften, die die Entdeckung des Milchzuckers irrthümlich auf BARTOLETTI's *Encyclopaedia Hermetico-dogmatica* (Bologna, 1619) zurückführen, auch meine *Zeittafeln* von 1928 und meine *Geschichte des Zuckers* von 1890. Ich gestatte mir aber zu bemerken, dass ich in der zweiten Auflage letzteren Werkes (Berlin, 1929, S. 678 ff.), im 15. Abschnitte " Die Ersatzmittel des Rohrzuckers," jenen Fehler bereits berichtigte, und als wahre Quelle BARTOLETTI's *Methodus in dyspnoeam* (Bologna, 1633, fussend auf Vorlesungen von 1629) angab. Deren Auffindung war ein Verdienst Prof. Dr. W. FLEISCHMANN's in Göttingen, der seine ausführliche Abhandlung in SUDHOFF's *Archiv für Geschichte der Medicin* (Bd. IV, S. 1-19 von 1910 veröffentlichte. An der erwähnten Stelle meiner *Geschichte des Zuckers*, auf die ich betreff sonstiger Einzelheiten verweise, theilte ich auch mit, dass sich eine bisher anscheinend völlig übersehene Angabe hinsichtlich des Milchzuckers schon 1583 auf S. 8 von THURNEISSER's *Magna Alchymia* (Berlin, 1583) vorfindet, denn das von ihm beschriebene " herrliche Salz " aus Molken, das er auch als wirksames Heilmittel " mit grossen Nutz oft und dick gebraucht," war

sicherlich nichts anderes als Milchzucker. Dass sich ein solches "Salz" unter Umständen aus Molken abscheiden lässt, war vermuthlich den Praktikern längst bekannt; auch BARTOLETTI erhebt keinen Anspruch auf die Neuheit dieser Thatsache.

(Halle a. S., 1936) EDMUND O. von LIPPMANN.

Reviews

Shio Sakanishi.—*An essay on landscape painting*, by KUO HSI. Translated from the Chinese. A foreword by L. CRANMER-BYNG. 64 p. London, MURRAY, 1935 (2/6 s.).

This charming booklet is a part of the well known " Wisdom of the East " series, thanks to which much of the best oriental wisdom had been widely diffused. Says Miss SAKANISHI

" KUO HSI, whose *tzû* was SHUN-FU, was born in Honan Province about 1020. Of his parents and of his early education we know practically nothing. A few phrases in the Preface to *An Essay on Landscape Painting* written by his son KUO JO-HSÛ tell us that he followed the teachings of LAO-TZŬ, and that before him there were no traditions of painting in the family. We also know, from a statement in the *Hsüan ho hua p'u*, that he was admitted at an early age to the Imperial Academy of Painting and soon made himself known for his bold and masterly brush-work... In middle life he acquired great fame as a landscape painter, for he was called to the court to paint large frescoes on the walls of the Imperial Palace. Later still he became a member of the Imperial Council and held various honorary offices " (p. 21).

There is in the Palace Museum in Peiping a kakemono entitled " Early spring," signed by KUO HSI and dated by him (a year equivalent to) 1072; there is also a makimono ascribed to him (1) in the Freer collection, Washington, entitled " Autumn in the valley of the Yellow River." The Peiping scroll I have not seen but the Washington one I have had various opportunities of admiring and a partial photograph is before my eyes as I am writing : it is an exquisite landscape. (2) To appreciate this

(1) The attribution goes back to the Ming dynasty, and the painting has never been ascribed to anybody else. Hence this particular attribution can be accepted with as much confidence as any relative to a Chinese painting. Thanks to Dr. J. E. LODGE, Curator of the Freer Gallery, for the information kindly supplied by him (letter 3602.06).

(2) There is also a kakemono ascribed to KUO HSI " Mountain scene after snow " in the St. Louis Museum (see *Bulletin* of that Museum, vol. 5, p. 26-27, 1920), and there is a makimono " Mountain scenery " ascribed to him in the Boston Museum. All of which suggests that there may be still other paintings by him or ascribed to him in other museums : I have not tried at all to make a complete list of his paintings, but only mentioned those of which I happened to know. However, ascriptions of Chinese paintings are in general very adventurous, and the wary prefer to speak of schools rather than of individual painters. See my essay, " Art as an approach to Asia," in *Yale Review* (April 1926, 540-52).

翰林待詔直長贈正議大夫郭熙淳夫撰

山水訓

君子之所以愛夫山水者其旨安在丘園養素所常處也泉石嘯傲所常樂也漁樵隱逸所常適也猿鶴飛鳴所常觀也塵囂韁鎖此人情所常厭也烟霞仙聖此人情所常願而不得見也直以太平盛日君親之心兩隆苟潔一身出處節義斯係豈仁人高蹈遠引爲離世絕俗之行而必與箕潁埒素黃綺同芳哉白駒之詩紫芝之詠皆不得已而長往者也然則林

fully it is well to remember that there was no landscape painting at all in the West at that time !

" KUO HSI's *Essay on landscape painting* has been read for centuries by Chinese and Japanese artists and has been extremely influential in shaping the course of the later schools of landscape painting. It is made up of the sayings of KUO HSI to his son, who after his father's death put them into their present form. The essay falls into four sections : Comments on landscapes; The meaning of painting; Rules for painting; A supplement to the rules for painting. To the last is appended another very short section consisting of a few anecdotes about KUO HSI's work; it has no connection with the essay proper. In the present translation the fourth section has been omitted, because critics agree that it is an interpolation of a very much later period. The translation is based on the two Chinese editions of the *Lin ch'üan kao chih :* in the *Wang shih hua yüan* and the *Mei shu ts'ung shu ;* and a short extract in the *Hua hsüeh hsin yin* " (p. 19).

Thanks to the courtesy of the Library of Congress and of the author I am able to reproduce the first page of KUO HSI's famous Essay as it appears in the *Wang shih hua yüan* (WANG's collection of art criticisms) printed in the last quarter of the sixteenth century.

For the sake of comparison I may refer the reader to my review of the *Chieh tzu yüan hua ch'uan*, translated into French by the late RAPHAEL PETRUCCI (Paris, 1918; *Isis* 4, 345-7), a work of the same kind, more elaborate and more concrete it is true and much later in date (end of seventeenth century) but continuing millennial traditions. The earliest Western writings which are at all comparable, though in some respects on a lower level, are those of LEONARDO DA VINCI, but LEONARDO came only four centuries after KUO HSI and a thousand years after HSIEH HO ! Western critics of oriental thought should always bear that in mind and be very humble.

In connection with Miss SAKANISHI's book I would like to draw attention to the study of the late BENJAMIN MARCH on *Some technical terms of Chinese painting* (1935; *Isis* 25, 572) published under the auspices of the American Council of Learned Societies. This is a very useful study which makes us deeply regret the author's premature death. It is almost entirely devoted to " landscape painting " which is " the alpha and omega of Chinese painting..., the first subject of the novice, and the ultimate accomplishment of the greatest master..." It includes 295 terms each of which is given in Chinese type and also in Wade-Giles transcription, translated and explained. Similar glossaries had been published before, e.g., in PETRUCCI's book mentioned above, but none done as thoroughly. The author did not investigate the matter only in a bookish way, he actually practised the methods of Chinese landscape painting under the direction of a well known painter, LIN YÜ-TS'ANG.

To continue our comparison between Chinese and Occidental painting,

let us add two more remarks : the people of the West studied anatomy while those of the East devoted their powers of observation almost exclusively to the landscape, and least of all to human figures. This is a good illustration of what PERCIVAL LOWELL called the impersonality of the East. In the second place, while books of the kind of KUO HSI's are entirely lacking in Western literatures (I say " entirely " for LEONARDO's notes are overlapping the Chinese field only to a small extent), we have a whole series of medieaval treatises on the methods of limning, preparing paints, etc. such as the treatises which Mr. DANIEL V. THOMPSON is investigating with so much zeal and skill (see his articles published in *Isis* 22, 456-68, 1935; 24, 382-96, 1936), and many others referred to in our bibliographies.

These remarks illustrate the fundamental importance of the history of art if we would understand the varieties of human intelligence and sensitiveness. This is especially true with regard to oriental civilizations which are otherwise sealed to the majority of scholars because of insuperable linguistic difficulties.

GEORGE SARTON.

Martin Müller.—*Die Quaestiones Naturales des Adelardus von Bath*, herausgegeben und untersucht. Münster i.W., 1934, Band XXXI, Heft 2, *Beiträge zur Geschichte der Philosophie und Theologie des Mittelalters*, viii, 92 pp.

It is gratifying to see the *Beiträge*, after a good many successive volumes devoted to theological and philosophical works, turn to one in the field of natural science again. Especially satisfactory is it to have the important twelfth-century *Natural Questions* of ADELARD OF BATH made accessible in a modern critical edition. Dr. MÜLLER's text is based primarily upon Latin MS 2389 of the Bibliothèque Nationale, Paris, the same used by WILLNER for his edition of *De eodem et diverso* by the same author in 1906, and a " thoroughgoing comparison " with four other manuscripts of the twelfth century and one of the fourteenth. Twenty-two manuscripts in all are listed, without as much accompanying description as might be desired. The list does not include Vienna 2351, double columns, membrane, fols. 1 r-17 *v*, where the text is disguised under the rubric, " Phylosophia Anshelmi Anglici," but opens and closes with the same words as MÜLLER's edition. Digby 11 is incorrectly designated as a manuscript of the British Museum, London, instead of the Bodleian, Oxford. Prag, 1650 (Univ. Bibl. H. 32) is listed, but its supporting the dedication of the work to RICHARD, bishop of Bayeux by its opening words, " Ricardo Baiocensi episcopo..." is not mentioned at p. 2, note 1, as one might expect.

The text offered seems fairly satisfactory but by no means perfect. For example, p. 1, line 22, " quem quidam auditoribus suis utilem esse scio," should be " quem *quidem*..." to make sense; p. 5, line 5, " teque eas edisserente ego... obviabo," should be either " teque eas *edisserentem* " or " *tibique* eas *edisserenti*." At p. 54, lines 7-8, " Cum enim huius mundi sensilis corpus quattuor elementa componant," probably should read, " Cum enim huius mundi *sensibilis*..." The punctuation sometimes seems unnecessarily abundant, not to say superfluous, as at p. 24, line 18, " Ex praedictis, ea, quae causaris, procedunt "; sometimes inconsistent, as at p. 25, line 16, " Audio quod rogas, non intelligo, quid interrogas." I also have the impression that more variant readings might have been given. For example, at p. 3, " 39. Quare lacte magis nutriantur homines." I think that the Eton College manuscript has *prius* rather than *magis*. Furthermore, it makes better sense.

The *Untersuchung*, at pp. 72-91, consists of a brief biography of ADELARD, based on the previous literature of the subject rather than new investigation, and a synopsis of the *Natural Questions*. There is no Index.

Columbia University, New York, U.S.A. LYNN THORNDIKE.

Edward Thompson.—*Sir Walter Ralegh : The Last of the Elizabethans.* XVI+387 p., 6 pl. London, MACMILLAN & CO., 1935 (15 s.).

This new life of SIR WALTER RALEGH is written in an interesting and readable style and should bring its hero's tempestuous career to the attention of a group of modern readers unacquainted with the older biographies. From its pages they should gain a keener understanding of sixteenth century England, for RALEGH was indeed an epitome of his age. He embodied in his own person all that intense and passionate individuality, all those many-sided interests and activities that are typical of the men who made Elizabeth's reign a supreme period of English history.

Mr. THOMPSON, however, adds nothing new of importance to our knowledge of RALEGH. He has made himself thoroughly familiar with all that has been written about RALEGH in the past; in fact, he cites as his justification for attempting a new life at this time the recent publication of EDWARD HARLOW'S *Ralegh's Last Voyage* (1932), which has created the need for a new biography that takes his conclusions into account. On the other hand, since the author has made no significant original investigations, his life of RALEGH, despite the footnotes inserted throughout the book, can never aspire to rank as the definitive biography of that great Elizabethan adventurer. Scholars will continue, as in the past, to go back to the works which Mr. THOMPSON has used as

his authorities, and will avoid his occasional tendency to assign equal weight to writers who differ greatly in merit and reliability. But regardless of the criticisms that might be offered on minor points, the main outlines of Mr. THOMPSON's picture of RALEGH are essentially true and accurate. His is not one of the fictional biographies of the psychoanalytic school so popular in recent years, but an honest attempt to draw a portrait of his hero which will accord with all the known historical facts. A more thorough knowledge of the thought and literature of the English Renaissance, however, would have saved the author from such misguided enthusiasm as prompts his characterization of RALEGH's style as " direct and vigorous, almost unique amid the lumbering Elizabethan prose." (p. 79.) No student of the literature of that period would detract from the great merits of RALEGH's prose, but directness and vigor were qualities which it shared with much of the scientific, political, and religious writing of the time. All Elizabethans did not write in the style of *Euphues*.

RALEGH was one of the inquiring spirits of his age who was most keenly interested in the discovery of new scientific knowledge, but Mr. THOMPSON has nothing new to add concerning this phase of RALEGH's activities, a phase which cries out for a more searching investigation. So far is the author from being at home amid the scientific world of sixteenth-century England that he fails to appreciate the real importance of JOHN DEE as one of the most eminent scientists of RALEGH's age, an importance ably demonstrated by Professor E. G. R. TAYLOR in her *Tudor Geography* (1930). Missing the full significance of RALEGH's friendship with DEE, Mr. THOMPSON even speaks condescendingly of the latter as a " funny old man who was liable to be visited by a spiritual creature at midnight."

Despite these occasional shortcomings, however, this book deserves genuine praise as a conscientiously written popular biography. But it is not the new life of RALEGH that students of the Elizabethan period would like to see in print, one which would combine thorough historical knowledge of those times with original and searching critical insight, in the fashion so notably exemplified in R. W. CHAMBERS' *Thomas More* (1935). Such a biography of RALEGH has yet to be written.

Stanford University. FRANCIS R. JOHNSON.

Henry W. Robinson and **Walter Adams.** *The diary of Robert Hooke* (1672-1680). XXVIII+527 p. London, TAYLOR & FRANCIS, 1935; 25 s. net.

R. T. Gunther. *Early science in Oxford, vol. X, The Life and Work of Robert Hooke (part IV).* XLIV+294 p. Oxford, 1935.

En 1929 (*Isis*, vol. XII, nº 38, pp. 237 sq.) et plus spécialement en 1931 (*ibid.*, vol. XV, nº 45, pp. 97 sq.), nous avons eu l'occasion d'entretenir les lecteurs de cette revue du journal de HOOKE (10 mars 1671/2-15 mai 1683), sur lequel notre attention avait été attirée lors d'un séjour à Londres, en novembre 1928. Dans notre article de 1931, nous donnions une description sommaire du manuscrit et, pour en souligner le puissant intérêt, nous en avions transcrit un bref passage. Nous émettions l'opinion que seule une publication intégrale de ce diary paraissait désirable, complétée par l'important fragment (1688-1693) découvert par Mr. H. W. ROBINSON au British Museum en juillet 1929.

Pour célébrer le tricentenaire de la naissance du savant anglais (1935), MM. HENRY W. ROBINSON, bibliothécaire de la Royal Society, et WALTER ADAMS, chargé de cours à l'Université de Londres, ont offert au public la partie du diary (de loin la plus longue) qui se trouve au Guildhall depuis 1891; (ils ont cru pouvoir négliger dans leur édition le début : 10 mars 1671/2-fin juillet 1672, ainsi que la partie finale, assez peu cohérente, du manuscrit, qui s'étend jusqu'au 15 mai 1683, et ont en conséquence arrêté leur transcription au 31 décembre 1680). La partie du diary relative aux années 1688-1693 est, d'autre part, publiée par les soins de Mr. R. T. GUNTHER, membre correspondant de l'Académie internationale d'Histoire des Sciences, et remplit la majeure partie du volume X de son ouvrage *Early Science in Oxford*.

HOOKE a une quarantaine d'années à l'époque du diary du Guildhall; il est donc dans toute la force de l'âge, s'il est permis de s'exprimer ainsi à propos d'un homme dont la condition physique fut presque continuellement chancelante : " The period of the Diary may prove to be the most active and productive period of his life " (p. XXVI). Dans notre étude de 1931, mentionnée plus haut, nous disions l'intérêt de ce journal, écrit par HOOKE pour son édification personnelle. Nous ne reviendrons donc pas sur ce sujet et nous nous bornerons à rappeler que ce document, qu'on peut qualifier de sensationnel, non seulement nous fournit un tableau de l'activité d'un des plus grands savants du XVII^e siècle : " It is scarcely an exaggeration to say that he was, historically, the creator of the Royal Society " (p. XX) (1)—que n'avons-nous, hélas ! un trésor équivalent de notes autobiographiques en ce qui concerne, par exemple, NEWTON !—mais ce journal, tout intime qu'il soit, constitue pour l'érudit une source inépuisable de renseignements infiniment précieux pour l'histoire générale du temps.

(1) Une étude préliminaire sur l'œuvre de HOOKE en tant qu'architecte, telle qu'elle nous est révélée par le diary du Guildhall, a été publiée, antérieurement à l'apparition du livre de MM. ROBINSON et ADAMS, dans *The Times*, Febr. 14, 1935, pp. 13-14.

Notons ici cependant que, plus encore peut-être que dans le volume I de la correspondance de MERSENNE (*Isis*, vol. XX, n° 59, pp. 467 sq.), nous rencontrons presque à chaque page de ce diary des preuves du fait qu'un homme de science illustre, vivant il y a trois siècles environ, est susceptible à chaque instant de penser comme un primitif ou comme un ignorant de nos jours, ce qui montre l'intérêt essentiel que présente aujourd'hui le folklore pour l'étude du progrès de la pensée scientifique.

Après l'histoire du manuscrit, vient une esquisse de la vie de HOOKE; on aurait aimé que les éditeurs recourussent à l'avis d'un médecin afin de nous donner une interprétation, qui était loin d'être superflue, du tempérament et des maux de l'auteur de la Micrographie; qu'on nous permette de signaler à ce propos que dans un court mais substantiel article intitulé : " De l'introduction des notions biologiques dans le domaine de l'érudition et de l'histoire " (*La Presse Médicale*, 10 février 1934, pp. 243-4), E. JEANSELME a souligné la nécessité pour les historiens d'avoir quelque teinture de biologie et de médecine.

Ce n'était certes pas une mince besogne que d'établir le texte. Le résultat obtenu par MM. ROBINSON et ADAMS nous paraît tout à fait satisfaisant, et on ne saurait assez les féliciter de leur patience. Il y a évidemment des erreurs de transcription et d'impression, mais elles sont inévitables dans une entreprise de ce genre; Mr. E. N. DA C. ANDRADE en a noté quelques-unes (*Nature*, vol. 136, 1935, p. 361).

L'index, qui est biographique, remplit plus de 50 pages et contient quelque 2.000 noms; c'est dire les services qu'il rendra; néanmoins, il aurait dû être développé au point d'être vraiment complet. Quoi qu'il en soit, il supplée dans une certaine mesure, ainsi que la liste des tavernes, à l'absence presque complète de notes explicatives.

Aucun portrait n'orne l'ouvrage. Toutefois, en se basant sur deux passages du diary (16 octobre et 24 décembre 1674), Mr. E. N. DA C. ANDRADE a suggéré (*Nature*, vol. 136, 1935, p. 604) qu'il existe peut-être un portrait de HOOKE, en sorte qu'il ne convient pas encore de se résoudre à renoncer à connaître un jour ses traits.

On ne saura jamais assez remercier MM. ROBINSON et ADAMS de nous avoir donné ce livre, qui constitue une contribution essentielle à l'histoire de la culture, mais nous devons hautement déplorer que l'index, dont nous avons dit l'insuffisance, n'ait pas été rendu plus utile, alors que tant de chercheurs se verront obligés de consulter ce savant et patient travail.

M. R. T. GUNTHER avait consacré à HOOKE les volumes VI et VII de son ouvrage *Early Science in Oxford*; nous avons analysé ici-même

(*Isis*, vol. XV, nº 45, Febr. 1931, pp. 174-7) ces deux volumes, intitulés : " *The life and work of Robert Hooke.*" Le volume VIII de *Early Science in Oxford* (*Isis*, vol. XVI, nº 49, November 1931, pp. 498-9) contenait *The Cutler lectures of Robert Hooke*. Le volume X de *Early Science in Oxford*, qui a paru à peu près en même temps que le livre de MM. ROBINSON et ADAMS, constitue donc la 4e partie de cette contribution à la vie et à l'œuvre du savant que M. GUNTHER n'hésite pas à appeler " the greatest English mechanical genius of the seventeenth century " (p. V).

Ce nouveau volume donne tout d'abord, en fac-similé, un mémoire de 1661, le premier travail de HOOKE : " An attempt for the explication of the phaenomena, observable in an experiment published by the Honourable ROBERT BOYLE, Esq.". Puis vient la reproduction, toujours en fac-similé, de quelques lettres de NEWTON et de HOOKE—dont aucune bien entendu n'est inédite (cf. W. W. ROUSE BALL, *An essay on Newton's* " *Principia*," 1893; pp. 139 sq.)—et de plans dûs à HOOKE, ainsi que sa liste autographe de catalogues de ventes de livres (d'août 1686 à août 1689).

Enfin, nous trouvons, remplissant plus de la moitié du livre, la partie du diary (1688-1693) découverte en 1929 par M. ROBINSON au British Museum (Sloane Ms. 4024), et qui était faussement attribuée à PETIVER (2). Ce n'est pas, comme le manuscrit du Guildhall, un journal régulièrement tenu, mais un assemblage de 194 petits feuillets détachés et en mauvais état qui, mis soigneusement en ordre par Mr. ROBINSON, ont montré qu'ils se rapportaient en réalité à deux périodes distinctes : novembre 1688-mars 1689/90 et décembre 1692-août 1693. Rappelons ici que dans le volume VII de *Early Science in Oxford* (pp. 577 sq.), M. GUNTHER avait publié quelques notes inédites de HOOKE (British Museum, Sloane 1039) s'étendant d'octobre 1681 à septembre 1683 et qui constituent l'ébauche d'un diary.

Le diary Sloane Ms. 4024 couvre 200 pages environ du livre; non seulement il nous fournit de nombreuses informations sur les contemporains du savant, mais il a aussi ce grand mérite de nous apporter des renseignements relatifs à l'activité de HOOKE à une époque de sa vie mal connue jusqu'à présent. L'établissement du texte était, cette fois encore, très pénible. Il y a un peu plus de notes que dans le livre de MM. ROBINSON et ADAMS, mais elles manquent souvent de précision et sont négligées, au point que l'auteur ne donne même pas d'une façon correcte les références à ses publications antérieures. L'index est désespérément incomplet.

(2) Une longue préface (pp. ix-xliii) souligne l'intérêt de ce fragment du diary et montre les difficultés qu'offre son déchiffrement.

Les historiens de la science ne seront pas seuls à regretter vivement que MM. ROBINSON et ADAMS d'une part, et M. R. T. GUNTHER d'autre part, n'aient pu s'entendre en vue d'une édition unique englobant tous les manuscrits; la reconnaissance qui est si justement due à ces savants aurait été plus grande encore s'ils avaient uni leur savoir et associé leurs efforts; il y aurait eu tout bénéfice, aussi bien pour l'intelligence du texte que pour l'utilisation par le public des documents capitaux qu'ils ont mis à sa disposition.

(Bruxelles.) J. PELSENEER.

James A. Thompson.—*Count Rumford of Massachusetts.* XVI+275 p., 10 illus. New York, FARRAR and RINEHART, 1935.

This is a popularly prepared but accurate and critical account of one of the most colorful scientific characters of the 18th Century. While the author, a kinsman of BENJAMIN THOMPSON, Count of Rumford (1753-1814), and a brother of the novelist KATHLEEN NORRIS, disclaims any attempt to appraise Count RUMFORD's scientific contributions, he does succeed in giving a fair account of them and of opinions on them. A bibliography appended to the volume makes it easy to obtain such data in detail. Unfortunately there is no bibliography of RUMFORD's own writings. These are accessible in the four volumes of his collected works issued by the American Academy of Arts and Sciences in Boston in 1871.

The present biography offers an excellent portrait of the man and his exciting career " with the technical aspect as a background only." The author concludes : „His scientific reputation I hold in profound respect; he was an organizer of marked ability and an excellent showman. But he was unbelievably cold-blooded, inordinately egotistic, inherently a snob. As a father to his daughter SARAH he was a complete and dismal failure."

Born in Woburn, Mass., BENJAMIN THOMPSON showed an inquisitive nature as a youth, and at 19 went as a teacher to Rumford, Mass., now Concord, New Hampshire. Here he promptly married a wealthy widow and ingratiated himself with the Governor. He was a Loyalist and there seems no doubt but that his spying on the revolutionists made it expedient for him to be sent to London. He was given the curious post of Secretary of Georgia and later became under-secretary of state. Meanwhile his experiments on the explosiveness of gun powder were an excuse for his election in 1779 as a Fellow of the Royal Society. This honor probably came from his intimacy with Sir JOSEPH BANKS, President of the Royal Society, who according to HUMPHREY DAVY, " readily swallowed gross flattery." In 1781 he sailed to America as a lieutenant-colonel, foraged in South Carolina, commanded a disreputable troop

on Long Island, and studied the velocity of bullets by an ingenious recoil method. At the close of the Revolution he returned to London and was pensioned a colonel. On the way to join the Austrian army, he was asked by Prince MAXIMILIAN of Bavaria to enter service there. With British permission and a knighthood from GEORGE III, he remained eleven years in Munich as minister of police and war. Here he made the most of his remarkable skill at organization, not only in the army and its nutritional and sanitary arrangements, but in the economic life of the city. He founded the famous "military workhouse" into which he herded 2600 beggars on New Year's Day, 1790. His scheme of making his wards happy first and then virtuous and industrious worked well and turned in a good profit. He extended his efforts to hospitals and reclamation of waste lands, establishing the still lovely English Garden, in which the grateful city erected a memorial to him. At Munich he studied food stuffs, began his efforts to improve fireplaces and made his famous observations on the heat generated by friction in connection with the boring of cannons. Most of these scientific studies were reported to the Royal Society. His quantitative work on heat excited the admiration of TYNDALL, who recognized RUMFORD as a conspicuous landmark in the establishment of heat as a form of motion.

In 1795 RUMFORD returned to England, brought his daughter over from America, developed a new stove designed to reduce smoke, and established the RUMFORD medals of the Royal Society and the American Academy of Arts and Sciences. Recalled to Bavaria, he was successful in keeping hostile French and Austrian armies from occupying Munich. He then came back to London and with Sir JOSEPH BANKS established the Royal Institution in 1800, selecting HUMPHREY DAVY as lecturer. RUMFORD's elaborate plans for the Institution were too much to carry out and he left for Paris in 1803. Here in 1807 he married the widow of LAVOISIER, but they quarreled almost from the first. RUMFORD retired in futile disappointment to Auteuil, where he died in 1814.

Interesting features of this account of RUMFORD are the illustrations and the brief accounts of the scientific leaders of his day with whom RUMFORD came in contact. In a second edition an index should be included. An accurate bibliography of RUMFORD's writings would also be a helpful addition.

(*University of California, San Francisco.*) CHAUNCEY D. LEAKE.

Marcel Delépine.—*Une étape de la notion d'atome et de molécule*; GAUDIN. *Bull. soc. chim.* (5), 2, 1-15 (1935).

MARC-ANTOINE-AUGUSTIN GAUDIN (April 5, 1804-April 2, 1880) in 1833 published in the *Annales de chimie et de physique* (2), 52, 113-133,

an article in which he says that he had already announced his ideas on atoms and molecules in a lithographed note of 1831. This *Note sur quelques propriétés des atomes* was addressed to the *Académie des Sciences* November 7, 1831. THÉNARD was charged with its presentation. On July 23, 1832, GAUDIN addressed another note, also lithographed, on the *Forme primitive des corps*. These with an *Aperçu des lois de la cristallisation* were finally presented by BECQUEREL at the meeting of August 6, 1832. The first lithographed note is dated October 30, 1831, and is now in the archives of the Academy, a 4to paper of 8 pages accompanied by a table of the atomic weights of simple substances and and attempt at the classification of fusibility and infusibility in relation to atomic weights. It was published, without the table, in the *Bibliothèque universelle de Genève* in 1833.

In this note GAUDIN says :

"Pour y parvenir" (that is, to discover the true atomic weights of simple substances), "voici comment je procède : ie donne d'abord une définition des mots Atome et Molécule, et simplifie le langage chimique; puis au moyen de la loi de M. GAY-LUSSAC, à savoir, que dans tous les corps gazeux, à même pression et température, les molécules sont toutes à la même distance, je démontre que les molécules des gaz, hydrogène, azote et oxygène, des vapeurs de brome, de chlore et d'iode, sont toutes biatomiques, ce qui rend parfaitement raison de toute les contractions de volume qui ont lieu pendant la combinaison, et j'en conclus que les gaz, hydrochlorique, hydrobromique et hydroiodique, sont biatomiques, que l'eau est triatomique, l'ammoniaque tétratomique... Au moyen de la densité de vapeur de mercure, des chlorures de silicium..., de bore..., je prouve que ces corps sont respectivement (mono) atomique, pentatomique et tétratomique."

GAUDIN's table of atomic weights was based on considerations of vapor density, specific heat, isomorphism, etc. It reported the relative weights of the atoms as compared with that of oxygen as 100. If his figures are calculated on the basis oxygen = 16 as is done at present, it appears that his atomic weights (except that of lithium) are neither multiples nor sub-multiples of those at present accepted but are identical with them within the precision of his data.

	Gaudin's figures		Present
	O = 100.	O = 16.	O = 16.
H	6.25	1	1
B	68	10.9	10.8
C	76	12.2	12
N	88	14.1	14
O	100	16	16
F	116	18.6	19
Li	127	20.3	7
Mg	158	25.2	24.3

Al	171	27.4	27.0
Si	185	29.6	28.1
P	196	31.4	31
S	201	32.2	32
Cl	221	35.4	35.5
Ca	256	40.9	40.1
Br	466	74.6	79.9
As	470	75.2	74.9
Sr	547	87.5	87.6
Sn	735	116.6	118.7
I	768	123.0	126.9
Sb	806	128.9	121.8
Ba	856	136.9	137.4
Hg	1265	202.4	200.0
Au	1248	199.6	197.2
Pb	1294	207.0	207.2

GAUDIN was a calculator at the *Bureau des longitudes*. He made numerous publications on photography. He was the first to prepare artificial rubies by the fusion of aluminum oxide with a little chromium oxide. It was he who prepared the fused quartz, inactive to polarized light, with which BIOT in 1839 demonstrated that the optical activity of natural quartz is due to its crystalline structure. In 1847 he published a book, *Recherches sur les groupements des atomes dans les molécules*, and in 1873 *L'Architecture du monde des atomes*. T. L. DAVIS.

Franz Xaver Kugler (1862-1929).—*Sternkunde und Sterndienst in Babel*. 3. Ergaenzungsheft zum ersten und zweiten Buch, von JOHANN SCHAUMBERGER. Mit 17 keilinschriftlichen Beilagen. V+152 p. (paginated 243-394)+17 plates. Muenster in Westfalen, Verlag der Aschendorfschen Verlagsbuchhandlung, 1935. RM. 18.

KUGLER's book, *Sternkunde und Sterndienst in Babel*, has become the standard work on Babylonian astronomy and astrology, including also valuable contributions to ancient chronology. It is the life work of a distinguished scholar, competent both in the fields of astronomy and Assyriology. The first volume, dealing with the Babylonian science of the planets, appeared in 1907, and the second volume came out in instalments 1909, 1912, and 1924. There are also two Ergaenzungshefte, supplementary fascicles, to the main book, written by KUGLER and published in 1913 and 1914. KUGLER died in 1929, and in the present third supplement Dr. SCHAUMBERGER continues his work with a few new texts and with additional notes and excursuses to the old texts. The continuation of KUGLER's book is also indicated by the pagination which goes from p. 243 to 394. A fourth fascicle, which will deal with chronology and contain the indexes to the whole work, is scheduled to complete the volume.

The author correctly points out that the texts, though largely astrological in character, prove the existence of a body of sound astronomical knowledge in the Babylonian schools. It is obvious that at very early times the Babylonians had already made systematic observations of the stars and their movements and had accumulated a goodly number of astronomical traditions in their schools and temples. The system of the lunary calculations by the great Babylonian astronomer KIDINNU, known for the last fifty years through fragmentary publications only, is here for the first time presented by SCHAUMBERGER in its complete form and provided with critical remarks.

Students of Babylonian mathematics will be interested to note that an old cuneiform text, distinguished through many archaic forms of symbols and words, exhibits also the double wedge reprensenting the Babylonian zero (see p. 356 of the book). THUREAU DANGIN takes it for granted that the zero was still unknown at the time of the first Dynasty (1). He knows of no example of the use of a zero symbol before the Seleucidian times (c. 300 B.C.) (2). NEUGEBAUER says that the earliest cuneiform text known to him to contain the zero may not be older than the Persian period (c. 500-400 B.C.) (3). However, it seems rather strange that the Babylonians should have employed for more than a millennium the positional system without its most fundamental element, the zero. It is therefore of the utmost importance for the history of mathematics to determine the age of this text found on one of the HILPRECHT Nippur tablets, now marked " Jena 228." The whole text is presented in the form of a mathematical equation. The distances of the stars are said to be in the proportion of 19:17:14:11:9:7:4, the sum is given as 120 *bēru*, and then the single distances are computed. Another astrological text (p. 354) uses the phrase *igi. gál. la*, which SCHAUMBERGER translates as " having eyes, endowed with insight, wisdom." The same phrase occurs also as the usual term employed in the so-called Tables of Reciprocals to indicate the conversion of the common fractions into sexagesimal fractions (4). One passage, however, referring to the history of science in general, has startled and puzzled me beyond words. Speaking of the influence which the Babylonian astrology exerted upon the West, the author remarks : (5) " Nur etwa vom 6. bis zum 12. Jahrhundert, also gerade in den *finstersten* Jahrhunderten des Mittelalters,

(1) See *Revue d'assyriologie*, 30, 144.

(2) See SARTON, *Isis*, 23, 1935, p. 163.

(3) See *Vorgriechische Mathematik*, p. 5.

(4) See NEUGEBAUER, *Mathematische Keilshrift-Texte*, I, op. 24, and my paper " The Babylonian Tables of Reicprocals," *Isis*, 25, 426-32.

(5) Preface, p. IV.

hat sich das Abendland von diesem Wahn wieder ganz frei gemacht. Das Schlagwort von dem *mittelalterlichen* Aberglauben der Astrologie mutet darum wie ein Hohn auf die Geschichte an." In English this would mean: "Only in the period from about the 6th to the 12th century, just in the *darkest* centuries of the Middle Ages, did the Occident again emancipate itself entirely from this delusion of astrology. The slogan of the *mediaeval* superstition of astrology sounds therefore like a taunt on history." A rather queer statement for a serious young scholar, which the esteemed author certainly is, to make. From these lines one must get the impression that the enlightened West of the early Middle Ages had deliberately, from its high vantage point of a scientific-rationalistic "Weltanschauung," rejected astrology as a mere delusion and superstition. A more distorted view of the historical course of events can hardly be found. With the same right one might also intimate that from the 6th to the 12th century did the Latin West emancipate itself from the delusion of the Euclidean Elements, because it preferred or anticipated the idea of a non-Euclidean geometry. To be sure, the West in those times was free from the higher forms of astrology. But it was also free of astronomy, free of the geometry of Euclid, entirely innocent of the medicine of GALEN, and wholly devoid of all the other arts and sciences.

The truth of the matter is, of course, as SARTON says (6), that "astrology spread East and West and was popular everywhere. But in Islam, it was balanced to a certain extent by a vigorous development of astronomy and the persistence of a few sound scientific traditions, while in the West, where the contact with such traditions was almost completely lost, it was entirely unmitigated... The higher form of astrology did not penetrate into the Latin West before the 12th century, and if it had penetrated, the Christians would have been unable to understand it; thus their astrology was largely of the baser kind." The so-called "dark ages" were in reality the bright, sunny Kindergarten period of the Western nations, in which they were still free from the "magic of the alphabet," from those clumsy "baneful signs" employed by the art of writing. That seems to be the reason why even that baser kind of astrology, which certainly did exist among the European tribes, has not been preserved. It remained a part of the oral folklore, most probably closely connected with the old pagan beliefs, and hence deliberately suppressed by the jealous Church. If, perchance, the esteemed author meant to allude to this fact of the suppression of the heathenish superstitions by the civilizing work of the Church, then the writer fully

(6) *Introduction to the History of Science*, I, p. 19.

agrees with him. Christianity emancipated the Western tribes, not from Greek astrology, but from their own crude and pagan ideas and from their native barbarian practices. Unfortunately, however, these pagan traditions, as it seems, stubbornly refuse to die. Again and again they sprout and shoot up anew, and unless curbed by a new, or revitalized old religion, they may spread like a flood of mire and slime over the world and drown our modern civilization.

SOLOMON GANDZ.

Alan H. Gardiner.—*The library of* A. CHESTER BEATTY. *Description of a hieratic papyrus with a mythological story, love-songs, and other miscellaneous texts.* 45 p., 61 plates by EMERY WALKER (The Chester Beatty papyri, no. 1). London, Oxford University Press, 1931 (folio).

Hieratic papyri in the British Museum. Third series. 2 vols. (the one quarto, the other folio). Vol. 1, XIII+142 p.; vol. 2, 72 plates. London, British Museum, 1935.

These three volumes contain an elaborate description of the nineteen CHESTER BEATTY hieratic papyri, the first of which the owner retained for his own collection (described in vol. 1, 1931), the other eighteen having been presented to the British Museum (described in the 2 vols. of 1935).

Pap. I contains the story entitled *The contendings of* HORUS *and* SETH which is valuable because of the paucity of mythological texts from Ancient Egypt. This text dates from the time of RAMESSES V (c. 1160). The *Contendings* is very different from other Egyptian tales, as for example the *Tale of the two brothers* (see *Isis* 21, 314) and the *Blinding of truth* (see below).

"These," remarks the Editor, "are humanized to such an extent that their actors might well be fictitious men and women, while in the 'Contendings' we are frankly and unmistakably moving in a world of gods—gods, it is true, prone to all the passions and enmities of mortals, but nevertheless the same old familiar figures of the Osirian cycle playing their accustomed parts, only a little less solemnly and a little less stiffly. In a word, the 'Contendings' is mythology up-to-date and somewhat in the spirit of OFFENBACH; 'The tale of the two brothers' and 'The blinding of truth' are folk-stories slightly moralized after the manner of HANS ANDERSEN" (1931, p. 9).

The same papyrus includes also love-songs, a fragment of a hymn, the encomium of RAMESSES V, and business memoranda.

Let us now consider the papyri which have become a part of the rich hieratic collection of the British Museum.

Pap. II contains the *Story of the blinding and subsequent vindication of truth*, already referred to.

The most important papyrus from the point of view of our readers is no. III, wherein they will find the prototype of those Dream-books of which mediaeval literature offers so many examples.

In my *Introduction* I did not attempt to give a complete history of oneirology, yet it contains sufficient information on the subject (facts and bibliography) to serve as a first guide. Consult the index, *sub voce* dream. Main references : vol. 1, p. 295, ARTEMIDOROS DALDIANOS (II-2), p. 558, AḤMAD BIN SIRIN (IX-1), p. 706, NAṢR IBN YA'QÛB (XI-1). Vol. 2, p. 397, JAGADDEVA (XII-1), p. 896, ARNOLD OF VILLANOVA (XIII-2) or WILLIAM OF ARAGON, p. 930, VINCENT OF BEAUVAIS, p. 941, pseudo-ALBERT, p. 979, ABÛ-L-FARAJ (the last three, XIII-2). Note the international range of those references.

Says Dr. GARDINER. Pap. III is " the earliest Dreambook in existence and may well date back to the Twelfth Dynasty (approx. 2000-1790 B.C.), though this cannot be proved with certainty. The core of the work consists of a long enumeration of dreams in clear tabular form, accompanied by their interpretations. A vertical column of large hieratic signs occupies the entire height of the page, and yields the sense " *If a man see himself in a dream...*' This clause has to be read before each separate horizontal line to the left of the column, only one horizontal line being allowed for each dream. The descriptions of the dreams are necessarily very terse, and are divided off from the interpreter's equally terse judgements upon them by a small space. The general scheme is thus as follows ' *If a man see himself in a dream doing so-and-so, good* (or *bad*); *it means such-and-such a thing will happen.*' Occasionally there are slight deviations, a circumstantial clause replacing the words ' *doing-so-and-so*', or else ' *it means* ' being omitted. From twenty-five to twenty-eight dreams go to the page, after which the scribe starts afresh from the top with a new vertical column. The good dreams form a solid block, like the less numerous bad dreams that follow. The word for ' *bad*,' being a word of ill omen, is written in red, the colour of blood " (p. 9).

And at the end of his analysis he concludes :

" No one can study the CHESTER BEATTY Dream-book without calling to mind JOSEPH's interpretation of the dreams of the chief butler and baker of Pharaoh, and it is interesting to note that the methods employed in the two cases are not far different. Between dream and interpretation there was necessarily a certain correspondence of idea, and it was this correspondence which enabled the interpreter to declare that the former protended the latter. Often the resemblance was restricted simply to the occurrence of the same word in the verbal descriptions, and paronomasia of this nature has frequently been indicated in the notes. Elsewhere the correspondence is more symbolical. For example, to see one's face in a mirror is to discover a second self, which second self must naturally have a wife; hence the interpretation ' *it means another wife.*' Again, to dream you are bringing in the cattle means that your people will be assembled to you, or if you see a large cat this signifies that your harvest will be a big one. Sometimes the interpretation is no more than an elaboration of the dream, as in 7, 16, where for a man to see himself eating what he detests is explained as meaning that he will do so unwittingly. A rarer form of correspondence is that manifesting itself

in contraries. Thus to see oneself dead is to have a long life in prospect. Very often, no doubt, the interpretation depended upon some superstitious association of ideas to which the clue is lost. And last of all there is much likelihood that in a number of cases the interpretation rested, not on any traditional ground or application of pseudo-logic, but solely on the caprice of the interpreter."

Any one who is at all familiar with dream books, whether Arabic or Latin, or those which are being peddled to this very day along the country roads all over the world, will recognize at once their main features in this Egyptian exemplar of four thousand years ago. Verily superstitions are as tenacious and irrepressible as the weeds of our gardens.

A part of Pap. IV is devoted to what the editor calls a " student's miscellany " (p. 37), a collection of edifying writings which formed the staple of a Ramesside scribe's education. The scribe's profession is glorified. Famous scribes of the past such as ḤARDEDEF and IMḤÔTEP (1) are praised. Similar texts are also found in Pap. V, as well as sequences of model letters.

The majority of these papyri contain magical texts (Pap. V, VI, VII, XI, XII, XIII, XVI) or magico-religious ones (Pap. VIII) or magico-medical ones (Pap. XV). Pap. VI and XVIII contain medical prescriptions; pap. X, fragments from a book of aphrodisiacs—a subject frequently represented in almost every oriental literature. Pap. IX which is (after pap. I) the longest in the collection, and dates from the time of RAMESSES II (XIIIth cent.), is devoted to a ritual of AMENOPHIS I (XVIth cent.), a book of invocations, and a book of protection.

These difficult and dismembered texts have been admirably edited by one of the great masters of Egyptian grammar, palaeography and literature, and the presentation of the results—facsimiles, transcriptions, translation and commentary—is splendid.

GEORGE SARTON.

B. Datta and **A. N. Singh.**—*History of Hindu Mathematics.* A source book. Part I, Numeral Notation and Arithmetic, XX+261 p. Motilal Banarsi Das, Lahore, 1935.

1. — *Arrangement and Contents*

The whole book is scheduled to appear in three parts; the second part will be devoted to algebra, and the third part to geometry and various topics of advanced mathematics. The volume before us is the first part which deals with numerical notation and elementary arithmetic

(1) JAMIESON B. HURRY (1857-1930) : IMHOTEP (2nd ed., Oxford, 1928; *Isis* 13, 373-5). G. SARTON : IMHOTEP, two statuettes in the Boston Museum (*Isis* 14, 226, 1 pl., 1930).

in two big chapters. The first chapter gives in eighteen sections a rather extensive discussion of the history of the Hindu numerals. After a general introduction, the authors deal with such interesting subjects as writing in ancient India, the *Brāhmī* and the *Kharoshṭhi* numerals, the place value system, the symbolic word numerals, the alphabetic notation, the zero, and the Hindu numerals in Arabia and in Europe. The chapter is concluded with numerous tables which demonstrate the development of the numerals. The second chapter contains fifteen paragraphs dealing with the four fundamental operations, the squares and cubes, checks on operations, the rule of three and some other commercial and miscellaneous problems, and the mathematics of the zero.

2. — *Antiquity of Hindu Civilization*

One of the most knotty problems in the history of science is the question as to the origin and antiquity of Hindu mathematics. Do the achievements of the Hindu mathematicians precede the time of the Greek influence, beginning with the invasion of ALEXANDER THE GREAT (327 B.C.), and rest upon the natural growth of native elements, or do they succeed the penetration of Hellenic culture and thus represent the reception and assimilation of a foreign civilization? In addition to that there is still the vexing question as to the possible contacts with the ancient oriental races of Egypt and Mesopotamia, or of Persia and China. The higher the rank of a civilization is, the less inclined are we to regard it as an isolated phenomenon independent of the achievements of the other nations. For the authors of our book these problems seem not to exist at all. They confine themselves to an array and a restatement of all the facts, or pseudo facts, and of all the evidence, or pseudo evidence, tending to support the orthodox theory of the high antiquity, of the originality and perfection of the Hindu civilization.

According to DATTA-SINGH (p. 1) the Vedas were composed about 3000 B.C., " or probably much earlier," the Brahmaṇa literature flourished c. 2000 B.C., and the beginnings of Hindu mathematics go back to that time. We are told that the cradle of our methods of performing the fundamental arithmetical operations is India, and that the " present method of expressing fractions is derived from Hindu sources and can be traced back to 3000 B.C." (pp. X and 186). To the European student these dates and beliefs have no other basis than the legends of the *Mahābhārata*. All that the critical historian will admit is " that the Vedic religion had been at work long before the rise of Buddhism in the 6th century B.C." From astronomical dates it has been inferred that the composition of the Vedas was going on about 1400 B.C. " But

these dates are themselves given in writings of later origin." (1) For a proper understanding of these things it must be borne in mind that Hindu literature was preserved by oral transmission. A literature transmitted by word of mouth only has no definite chronology and no clear distinction between the author and reciter, between the originator and transmitter. All the additions and improvements of the later generations are so edited as to blend to a seemingly organic unit. Another characteristic feature of Hindu literature is that it is based upon divine revelation and inspired tradition. Consequently there can be no references to foreign origins or foreign influences. "No early Indian writer mentions the invasion of ALEXANDER THE GREAT," says G. R. KAYE (2) and that is exactly the attitude of our authors. They simply conform to the orthodox tradition, everything is traced back to the hoary antiquity of 3000 or 2000 B.C., and the possibility of a foreign influence is entirely ignored.

And still there is abundant evidence to show the reality and the diffusion of foreign influences. In the time of DARIUS THE GREAT, c. 500 B.C., the valley of the Indus was a Persian satrapy. When ALEXANDER THE GREAT invaded India in 327 B.C., he was accompanied by a host of historians and men of science, of adventurers and merchants. Since that invasion the contacts between India and the Hellenic world continued for a long time. ALEXANDER founded cities and planted garrisons, and these Greek colonies exerted a powerful influence upon the spiritual life of the Hindus. References to the Yavanas occur in the literature, Greek and Roman coins are found at many places, and the names of Greek kings appear in the rock inscriptions under Indian forms. Similarly Greek methods and Greek technical terms may be recognized in the records of Hindu astronomy (3). Much older and much more fundamental must have been the Semitic influence. It has been generally conceded that the two kinds of script known in ancient India, the *Brāhmī* and *Kharoshṭhi*, are both derived from the Semitic alphabet. The *Kharoshṭhi* script resembles the Aramaic letters of the 5th century B.C. and it is written in the Semitic fashion from right to left. It was emlpoyed in certain parts of India from c. 400 B.C. to c. 200 A.D., and it was most probably introduced as a consequence of the Persian invasion of c. 500 B.C. The *Brāhmī* script resembles the Phoenician type of the Semitic alphabet and was believed to have been imported into India about 800 B.C. by

(1) *Encyclopaedia Britannica*, 11th ed., XIV, p. 395 f.

(2) *Indian Mathematics*, Calcutta, 1915, p. 2.

(3) See KAYE, *loc. cit.*. SARTON, *Introduction to the History of Science*, I, pp. 386 f. and 428; *Encyclopaedia Britannica*, 11th ed., XIV, p. 397 ff.

traders coming from Mesopotamia (4). Recently, the theory has been advanced that the *Brāhmī* alphabet is derived from the script of Mohenjodaro, and that through this the connection of *Brāhmī* with the South Semitic and Phoenician scripts is proved (5). It is, however, a great mistake on the part of our authors to identify the people of the Mohenjodaro civilization (c. 3250-c. 2750 B.C.) with the Hindus and to say that " the Hindus knew the art of writing in the fourth millennium B.C." (6) The fact is, quite to the contrary, that the archaeological excavations at Mohenjodaro, carried out by the government of India in the years 1922-27 and edited by Sir JOHN MARSHALL in the volume called *The Mohenjo-Daro and the Indus Civilization*, 1931, tend to confirm the hypothesis of an early Mesopotamian influence upon the Indo-Aryan culture. The archaeological finds prove, in the words of the editor Sir JOHN (*ibid.*, p. V), that " 5000 years ago, before even the Aryans were heard of, the Punjab and Sind... were enjoying an advanced and singularly uniform civilization of their own, closely akin but in some respects even superior to that of contemporary Mesopotamia and Egypt." This old and highly developed civilization was in all likelihood destroyed by the invading tribes of the Indo-Aryans who brought into India an inferior civilization of their own. Their relation to the old Mohenjodaro civilization may be likened to the relation of the Hellenic tribes to the Aegean civilization. It is historically impossible to think of Sanskrit as the Indus valley language, and of the Indo-Aryans as of the literary inhabitants of the cities of the Punjab, at such a date as 3000 B.C. (7).

3. — *The Hindu Numerals*

Half of the book is devoted to the discussion of the Hindu numerals, the greatest mathematical contribution of the Hindus. No wonder, therefore, that DATTA-SINGH are making great efforts to prove the real Hindu origin of these symbols and the high antiquity of this Indian invention. According to our authors the earliest epigraphic evidence found in India of the use of the new numerals with place value and zero is 595 A.D. " No other country in the world offers such an early instance of its use. Epigraphic evidence alone is, therefore, sufficient to assign a Hindu origin to the modern system of notation." (8) The earliest

(4) See L. D. BARNETT, *Antiquities of India*, p. 225-7; A. MACDONELL, *A History of Sanskrit Literature*, p. 14-16.

(5) See G. R. HUNTER, *The Script of Harappa and Mohenjodaro*, London, 1934. I am quoting from the short summary given in *Isis* 24, 1935, p. 257 f. Cf. also the book of DATTA-SINGH, pp. 10, 29.

(6) See p. 36 and cf. also pp. 1, 19, 29.

(7) See F. W. T. in *The Journal of the Royal Asiatic Society*, 1932, p. 464 f.

(8) P. 49, and 40.

use of the place value principle in the system of symbolic word numerals is supposed to go back to the second or third century A.D. Literary references to the place value system are said to be found from about 200 B.C. (9). The conclusions reached by the authors are therefore " that the place value system was known in India about 200 B.C.," and the possibility is even admitted " that further evidence may force us to fix an earlier date." The reviewer is unable to form an independent opinion with regard to Hindu inscriptions or references in Sanskrit literature. But he would like to mention that KAYE and other competent investigators of Hindu epigraphy question the reliability of the epigraphic evidence. The inscriptions were found on the so-called copper plate grants, many of which were proven to be forgeries. KAYE asserts that of the 17 inscriptions, antedating the tenth century A.D. and containing the decimal place value numerals, 16 have been eliminated as spurious by students of Hindu palaeography. The one left bears the date of 867 A.D. (10). On the other hand, it should also be noted that palaeographic instances, going back to the early part of the 7th century A.D. and testifying to the use of the place value notation, have been found in the Hindu colonies of the Far East, in Indo-China and Indonesia. In Indo-China, Sanskrit inscriptions have been deciphered which are using the symbolic word numerals with place value and zero and are dated of the years of the Šaka Era 526, 609 and 654, corresponding to the years 604, 687 and 732 A.D. On the Indian islands, inscriptions in the vernacular were found which contain numerals with place value of the dates of the Šaka Era 605, 606 and 608, corresponding to the years 683, 684 and 686 A.D. (11).

With regard to the literary references M. W. E. CLARK summarizes his opinion (12) " that the Indian literary evidence proves conclusively the presence of a symbol for zero by A.D. 600... It also proves the knowledge of nine symbols with place value (with either a blank column on the reckoning board for zero, or a symbol for zero) by the end of the fifth century A.D. at least. Beyond that the present evidence does not go." These dates are about 400 years earlier than the dates of KAYE, but about 700 years later than those of DATTA-SINGH. To the sixth

(9) See pp. 86-88.

(10) See *Indian Mathematics*, p. 31 f., and his articles in the *Journal of the Asiatic Society of Bengal*, vols. III, IV and VII, 1907, 1908, and 1911, and in *Isis*, II, 1914-19, pp. 326-56.

(11) Cf. G. COEDÈS, " A propos de l'origine des chiffres arabes," in the *Bulletin of the School of Oriental Studies*, University of London, VI, 1931, pp. 323-8, (*Isis* 20, 581), and see also DATTA-SINGH, p. 43-4.

(12) In his article " Hindu-Arabic Numerals " in *Indian Studies in honor of Charles Rockwell Lanman*, 1929, pp. 217-36, quoted by COEDÈS, *loc. cit.*

century as the lower limit of the date of their invention, or introduction into India, points also the testimony of the Syrian bishop SEVERUS SĒBŌKHT of 662 A.D. concerning the ingenious system of the nine numerals of the Hindus (13). On the ground of all this evidence it may well be safe to say that in the sixth century A.D. a decimal system of notation with nine numerals, place value and zero was known in India. By no means, however, are we entitled to proclaim the place value and the zero, the two fundamental elements of the system, as Hindu inventions. These devices are proved beyond doubt to have been well known to the ancient Babylonians and to the Maya of Central America. The Babylonians may have used the system of local value as early as 2000 B.C. The zero symbol was employed only in the middle of a number, and the earliest text in which it occurs belongs to the time of the Persians, c. 500-400 B.C. (14). How old the Maya system is we cannot tell, but authorities on the Maya civilization have asserted that their calendar began as early as 3373 B.C. At any rate their system of notation is certainly independent of the Hindu notation. While the Babylonians applied the place value to the sexagesimal scale, the Maya notation was based on the scale of twenty. All that the Hindus may claim for themselves is the first application of these principles to a notation based upon the decimal scale. It follows, therefore, as has already been well remarked by F. CAJORI (15), that the present controversy on the origin of our numerals does not involve the question of the first use of the local value and of the zero at all; it concerns itself only with their first application to the decimal scale and with the origin of the present forms of our ten numerals. It is now characteristic for the methods of our authors that these well established facts of the priority of the Babylonians and of the independent occurrence of the invention among the Maya are consistently ignored. Again and again the Hindu origin of the place value system and of the zero is stressed (16), but in the whole discussion of the subject, which occupies more than one hundred pages, not a word is said with regard to the Babylonian and Maya origins. But quite apart from all that, the historian of mathematics will not fail to realize that these two fundamental elements of our system of notation,

(13) See SMITH, *History of Mathematics*, II, p. 64; SARTON, *Introduction to the History of Science*, p. 493.

(14) See NEUGEBAUER, *Vorgriechische Mathematik*, p. 4-5, and *passim*. SMITH, *loc. cit.*, p. 37 ff. On the Maya notation see SMITH, *ibid.*, p. 43-5.

(15) See the lucid presentation of the whole problem in his paper "The Controversy on the Origin of our Numerals," *The Scientific Monthly*, IX, 1919, pp. 458-64.

(16) See especially pp. 27, 87 ff., 38 and 51.

the place value and the zero, are derived from the abacus, on which the columns or wires had their place value and the blank column, or blank counter, represented the zero. The abacus, however, appears to be one of those universal devices to the invention of which no single nation can lay claim. There was among the Peruvians a knotted cord abacus on which the pending ropes attached to the main cord marked the place value of the knot numbers and represented the columns of the abacus. As early as the sixth century B.C. the Chinese spoke already of the knotted cord as of an ancient and antiquated contrivance. Thus LAO-TZE, the philosopher of the 6th century B.C., said : " Let the people return to knotted cords and use them " (17). In some form or other the abacus was well known to all the civilized races, as the Babylonians and Egyptians, the Chinese and Japanese, the Greeks and Romans. In the tenth century the abacus reappears in western Europe as a legacy of classical antiquity, but without any connecting links to the Hindu or Arabian world. The columns have their place value, and the blank counters with the hole in the center represent the zero. This instrumental arithmetic of the abacus transferred into written form gives the modern system of notation with place value and zero. Hence the theory was advanced by BUBNOV (18) that our numerals were derived from the marked counters, and, therefore, commonly referred to as abacus numerals.

To say with KAYE, BUBNOV, DATTA-SINGH (19) and others, that the Hindus and Arabs had no knowledge of the abacus is entirely wrong. The abacus was well known to the Arabs and referred to by the two terms *takht*, the board, and *ghubār*, dust. The advanced stage of written arithmetic was called the abacus arithmetic, and the numerals were known as the ghubār numerals, which means " abacus numerals " (20). In like wise the Hindus called their abacus either *pāṭī*, board, or *dhūlī*, dust. And in contrast with the primitive forms of *mudrā*, finger arithmetic, and *ganana*, mental arithmetic, they coined for the advanced stage of the calculation on the abacus, the terms *pāṭī-ganita*, calculation on the board, and *dhūlī-karma*, dust work (21), both meaning : abacus arithmetic. The abacus simply became the symbol of the sciences of mathematics, among the Arabs and Hindus as well as among the Romans and the mediaeval mathematicians of the Latin world.

(17) See SMITH, *loc. cit.*, II, p. 195, and the whole very instructive chapter on the abacus, *ibid.*, pp. 156-96. Cf. also the writer's paper on the knots in *Isis*, XIV, 1930, p. 205 f.

(18) Cf. MRS. LATTIN's article in *Isis*, XIX, 1933, pp. 181-94.

(19) On p. 124.

(20) See the writer's article on " The Origin of the Ghubar Numerals " in *Isis*, XVI, 1931, pp. 393-424.

(21) DATTA-SINGH, pp. 8, 124.

With regard to the abacus, however, the priority of the classical civilization cannot be doubted. Hence the probability must be admitted that the abacus together with the " art of the abacus " and the " symbols of the abacus " wandered from the West to the East. The theory of the Hindu origin of our numerals rests mainly upon the testimony of the Arabs that they learned their numerals from the Hindus, and upon the assumption that the Europeans adopted the very same numerals from the Arabs. The foundations of this theory were considerably shaken by the writer's above mentioned paper on the origin of the ghubar numerals. In this paper the writer demonstrated first the familiarity of the Arabs with the abacus, the existence of the two Arabic terms " board " and " dust " for the instrument (22), and that these terms exactly correspond to the classic Latin terms *abacus* and *pulvis* or *pulvisculus*. It was further shown that the Arabs distinguished two types of numerals, the Hindu- and the ghubar numerals (23); that this latter term means abacus numerals, and that, by an abundance of indications, these ghubar numerals point to a western, Roman origin, and not to India. Not only were they generally called *'uqūd*, " joints, knots," which is the Arabic rendering of the Latin *articuli*, but, according to the testimony of MAIMONIDES (1135-1204), they were also traditionally known as *al-'uqūd al-rūmī*, " the Roman, or Greek knots."

Two years later the theory was further corroborated by an interesting paper of GEORGES S. COLIN, entitled " De l'Origine Grecque des Chiffres de Fès et de nos Chiffres Arabes " (24). In this paper COLIN reports about the existence of a notation of 27 numerals employed by the notaries of Fes, which is called *al-qalam al-Fāsī*, the Fes notation, and about which tradition says that it was derived from the Roman or Greek notation. Unaware of my paper in *Isis* and entirely independent of it, COLIN suggests the Greek origin of the Fes numerals and of our Arabic numerals. The summary of this theory, on pp. 214-5, reads :

I. — The 27 numerals of the Fes notation follow the Greek system of the 27 alphabetic numerals, and represent a mixture of symbols adopted from the Greek and Arabic alphabet and from the ghubar numerals.

II. — Due to the ancient use of the column abacus, the first nine numerals assumed a place value. The rest of the numerals was discarded.

III. — These nine symbols were carried into the wide world by the

(22) This was already established in the writer's article " Did the Arabs know the Abacus ? " *American Mathematical Monthly* 34, 1927, pp. 308-16.

(23) Both types were known to AL-KHUWĀRIZMĪ (c. 820), who refers to the differences in the symbols for 5, 6, 7 and 8 in his *De numero Indorum*, p. 1.

(24) In *Journal Asiatique*, 1933, pp. 193-215. The article was called to my attention by Dr. SARTON.

Neo-Pythagoreans of Alexandria. Through the medium of the Roman *apices* they became the prototypes of the ghubar numerals. They penetrated into India and from there to the eastern Arabs. The European Arabs, however, adopted the ghubar type.

IV. — A modern Moroccan jurist writing about the Fes numerals says that they were originally drawn from the ancient *Rūmī* notation (25).

V. — A comparative table of the Greek, Coptic and Fes forms of the 27 numerals is given on pp. 199-201 in order to illustrate the Greek origin through the Coptic medium. The Greek letters and numerals were adopted by the Copts in the third century A.D. In 640 Egypt was conquered by the Arabs, but the Coptic scribes remained the officials of the administration. Hence the 27 numerals were first adopted by the Arabs in Egypt, from there they came to Spain and thence to Morocco.

DATTA-SINGH (on pp. 89-91) admit the likelihood that the Arabs knew the ghubar numerals, without place value and zero, long before they had direct contact with India. They also concede that they must have obtained them from the Alexandrians or the Syrians. But there is no reference to the papers of GANDZ or COLIN. Apparently, they had no knowledge of these recent studies, or, possibly also, that they chose not to take cognizance of them.

4. — *A few Critical Remarks concerning Details*

Owing to the great uncertainty of the dates in early Hindu mathematics, SARTON preferred it to postpone the discussion to a future chapter (26). It is perfectly clear that in a book arranged according to centuries and half centuries, the *Sulvasūtras* which are dated as between 500 B.C. and 200 A.D. could hardly find the proper place. KAYE (27) distinguishes three periods in Hindu mathematics : I. The *Sulvasūtra* period. II. The astronomical period, 400-600 A.D. III. The Hindu mathematical period proper, 600-1200 A.D. He notices the remarkable fact that the second and third periods have no connection whatever with the first or *Sulvasūtra* period. "The later Indian mathematicians completely ignored the mathematical contents of the *Sulvasūtras*. They never refer to them nor do they utilise the results given in them." In the writer's opinion, this strange behaviour may be due to the fact that the later mathematicians were conscious of the foreign origin and of the superior character of their knowledge and were loath to place it side by side with the primitive rules of the old *Sulvasūtras* and thus invite an unfavorable comparison.

(25) The above quoted testimony of MAIMONIDES shows that this is an old tradition. As COLIN remarks, *Rūmī* may denote : European, Roman or Greek.

(26) See *Introduction*, I, pp. 36, 74.

(27) *Indian Mathematics*, p. 3; cf. also p. 9, note.

A somewhat similar phenomenon may be observed in Hebrew mathematics. The later mathematicians of the Arabic period (from c. 1100 on), like SAVASORDA, IBN EZRA and the others, never refer to the *Mishnat ha Middot*, the genuine Hebrew geometry of c. 150 A.D., corresponding in its primitive character to the *Sulvasūtras* (28). With regard to the names for the decimal powers DATTA-SINGH (on p. 9) stress the fact that the ancient Hindus had special terms for no less than eighteen denominations, whereas the Greeks did not go beyond the myriad and the Romans even stopped at the mille. Even in modern times, they say, " the numeral language of no other nation is as scientific and perfect as that of the Hindus." A multitude of words for single numbers and conceptions, however, is by no means a sign of perfection. Primitive languages have this peculiarity, while the modern languages of an advanced civilization have more words for general classes and abstractions. The very characteristic of the high standard of our numerical system consists in the fact that through it we are able to dispense with this bewildering multitude of special verbal or notational symbols for each denomination. Truly scientific was the Greek arrangement into octads and tetrads. The use of the centesimal arrangement in the *Lalitavistara* (29), a Buddhist work of the first century B.C., may be due already to Greek influence.

On p. 210 our authors say, " the rule of three occurs in the treatises of the Arabs and mediaeval Latin writers, where the Hindu name ' Rule of Three ' has been adopted." The Arabs certainly did not call it by that name. They deal with the subject in a chapter on " Business transactions," or " Commercial transactions," *Bāb al-mu'āmalāt* (30). The origin of the rule of three goes back to the Egyptians and Babylonians.

Contrary to the assertion of our authors (on p. 101 f.), I wish to emphasize that no " competent authority " ever stated that the words *handasa*, *handasi* etc. are adjectives formed from *Hind* and mean " Indian.' There is no connection whatever between the two words. *Hindi* means " Indian " and *handasa* means " measure, surveying, geometry." It is a Persian loanword and occurs already in the Aramaic papyri of 447 and 410 B.C. (31). The Hindus have a method of expressing numbers by names of things which are associated with that number. For instance,

(28) Though IBN EZRA, at least, knew of its existence and mentioned it at the beginning of his *Yesod Mora*.

(29) DATTA-SINGH, p. 11.

(30) Cf. my note on " The Rule of Three in Arabic and Hebrew Sources " in *Isis* 22, 1934, pp. 220-22, and see also paragraph 5 of my paper " Mene mene tekel upharsin," to appear in *Isis*.

(31) See the writer's edition of the *Mishnat ha Middot*, p. 69, note 15.

the number two is referred to by such words as " eyes," " hands," or of other things occurring in pairs. It is a poor terminology to call these numerals " word numerals," as DATTA-SINGH do (on p. 53 and passim). The proper term would be symbolic, or associative, word numerals. Thus KAYE (32) speaks of a " word-symbol notation." Word numerals are the regular, spoken number words, one, two, three, etc., in contradistinction to the written number symbols, which are the written numerals.

The term *hanana* and its synonyms, meaning " killing, destroying," which are used for multiplication (33), seem to have a common origin with the still unsatisfactorily explained Arabic term *ḍaraba*, " to strike, kill " (34).

In conclusion I would like to say that the book before us certainly contains an abundance of material for the history of Hindu mathematics, but the material presented has to be used with caution. The authors, as native Hindu scholars, certainly are possessed of a deep erudition in Hindu literature, but they display a lack of training in the modern methods of philological and historical criticism, which deficiency is still enhanced by a too perspicuous bias and tendency towards exaggerating the achievements of the Hindu race. As an industrious collection of material and as a starting point for further critical investigation the present volume is very welcome indeed. But on the whole it impresses us as a mathematical panegyric on Hindu history. A History of Hindu Mathematics still remains to be written.

New York City. SOLOMON GANDZ.
January 23, 1936.

Annals of science.—*A quarterly review of the history of science since the Renaissance.* Editors: D. MCKIE, HARCOURT BROWN, and H. W. ROBINSON. Vol. 1, January 15, 1936, No. 1, 113 p., 11 pl. London, E.C.4, TAYLOR and FRANCIS, Red Lion Court, Fleet St. (Annual subscription £1).

As its title indicates this new journal will be restricted to the study of modern science. We greet its publication with special pleasure and send our best wishes to its editors. Our forty-sixth Bibliography contains an analysis of the first number—which is splendid—and ulterior numbers will be analyzed in the same manner. Thus our Critical Bibliography will include, among other things, a classified list of the papers published in the *Annals of science*, and readers of *Isis* may feel confident that no

(32) *Indian Mathematics*, pp. 27, 31.
(33) See pp. 134, 137 and 139.
(34) See the writer's paper " The Terminology of Multiplication," *The Hebrew Union College Annual*, VI, 1929, pp. 247 ff.

document appearing in the *Annals* will be allowed to escape their attention.

The three editors of the *Annals* are very favorably known to our readers. HENRY W. ROBINSON is Librarian of the Royal Society and takes advantage of his position, not to play the part of Cerberus, but on the contrary to show every civility and courtesy to students interested in the rich archives of the R. S., whether they be F. R. S. or not. Witness the testimony of E. F. MACPIKE in the preface to his *Correspondence and papers of* EDMOND HALLEY (Oxford, 1932; *Isis* 20, 470-2). ROBINSON has recently edited with WALTER ADAMS *The diary of* ROBERT HOOKE (London, 1935). DOUGLAS MCKIE is lecturer on the history of science in University College, London. He has published many studies on chemistry in the eighteenth century, notably his excellent book on *The discovery of specific and latent heats* (London, 1935; *Isis* 25, 227) and more recently his LAVOISIER (London, end of 1935). HARCOURT BROWN is professor of French literature in Washington University, St. Louis, Missouri. He is especially interested in French science of the seventeenth century. We owe him an excellent book on the *Scientific organizations in seventeenth century France* (Baltimore, 1934; *Isis* 22, 542), and other related studies such as the one on HENRI JUSTEL (Paris, 1933; *Isis* 22, 351). He has made an elaborate investigation of the early academy of Caen (1665-76), which is still unpublished. It is clear enough that the *Annals of science* are in good hands. May they prosper! We are looking forward to many happy years of friendly collaboration and emulation with them. G. S.

A. Voss.—*Die Beziehungen der Mathematik zur Kultur der Gegenwart.* **H. E. Timerding.**—*Die Verbreitung mathematischen Wissens und mathematischer Auffassung.* (*Die Kultur der Gegenwart, ihre Entwicklung und ihre Ziele*; Dritter Teil: *Mathematik. Naturwissenschaften. Medizin.* Bearbeitet unter Leitung von F. KLEIN, E. LECHER, R. v. WETTSTEIN, Fr. v. MÜLLER; Erste Abteilung: *Die mathematischen Wissenschaften*, unter Leitung von F. KLEIN.) Leipzig, TEUBNER, 1914.

These excellent summaries by two of the old Germany's distinguished mathematicians date from another age. Since these works issued from the press, the Great War devastated Europe, a German Republic rose and apparently flourished, and now we see the so-called Drittes Reich, which wishes to assert that a single nation is sufficient unto itself and wishes to have us believe that naive postulate that all really worth-while advances have been made by "pure Aryans."

Voss and TIMERDING in their thoughtful discussions show clearly

that, both with respect to the applications of mathematics to general culture and with regard to the spread of mathematical method, all the great civilizations of the world have played important roles. Voss, in his summary, covers the major events in the study of the part of mathematics in the intellectual conquest of the physical world, the modern world of machinery, and of electricity, with telephone and wireless. TIMERDING covers largely the same actors in this the greatest part of the human drama but from the point of view of the conquests of mathematical method.

One chapter necessarily fails in both accounts. The tremendous achievements of the Babylonians, the partially Semitic achievements so recently discovered and now systematized by the scholarly activity of OTTO NEUGEBAUER, this story would only have added to the demonstrated universality of the mathematics and the mathematical method. In some happier day than November 1 of 1935 we may believe again that the things of the mind are supreme and that despicable physical power cannot conquer the world of ideas and idealists, neither in Germany nor in Italy nor in Ethiopia. VOSS and TIMERDING have in the course of relatively few pages made this clear for the historical past of mathematical science.

The topics treated in the two works are as follows :

A. Voss :

Verehrung und Geringschätzung der Mathematik;
Unrichtige Ansichten über Mathematik;
Entstehung und Widerlegung solcher unrichtigen Ansichten;
Unpopularität des mathematischen Denkens;
Technische Erfindungsgabe und quantitative Forschung;
Mathematik und Kultur bis zur Zeit der Renaissance;
Newtons Principia und die Infinitesimalrechnung;
Mathematisch-physikalische Forschung;
Fernewirkung und Feldwirkung;
Mathematik und technische Wissenschaften;
Energieprinzip und Thermodynamik;
Energieprinzip und mathematische Chemie;
Wahrscheinlichkeitsrechnung und ihre Anwendungen;
Morphologie, Biologie, Physiologie, Medizin und Mathematik;
Mathematik und Philosophie bei den Pythagoreern, PLATO und ARISTOTELES;
Mathematik und Philosophie bis zur Zeit GALILEIS;
GALILEI, DESCARTES, NEWTON, SPINOZA, HOBBES;
LOCKE, LEIBNIZ, WOLF, KANT;
KANTS transzendentale Ästhetik und die spätere Philosophie in Deutschland;
Mathematik und Schulunterricht;
Bildungswert der Mathematik;
Wert der mathematischen Forschung an sich;
Internationale Verbreitung der Mathematik.

H. E. TIMERDING :

Einleitung;
Die mathematische Bildung der Ägypter;
Die mathematische Bildung der Griechen;
Die mathematische Bildung des früheren Mittelalters;
Die mathematische Bildung in der Zeit des Scholastizismus;
Die mathematische Bildung der Renaissance;
Die mathematische Bildung des 17. und 18. Jahrhunderts;
Der mathematische Unterricht in Deutschland während des 19. Jahrhunderts.
Die Ausgestaltung des modernen mathematischen Bildungswesens.

Ann Arbor, Michigan. LOUIS C. KARPINSKI.
November 1, 1935.

Max Sasuly.—*Trend Analysis of Statistics.* XIII+421 p. The Brookings Institution, Washington, D. C., 1934. (Price $5.00.)

Some apology, perhaps, should be offered for the review in the pages of *Isis* of so technical a treatise as the present one. This apology is found, however, in the character of the problem treated in the book, a problem whose origins go back more than a century into the rich pages of the history of mathematics. The book is devoted to a discussion of the methods which have been devised to approximate to the value of a function by means of polynomials.

The problem arose with the first enunciation of the theory of least squares by LEGENDRE in 1806, and the subsequent development of this theory by LAPLACE and GAUSS. The most obvious application of the principle of least squares was to the case of polynomial approximation and a large number of papers have been devoted to the subject.

The problem in the general sense is essentially divided into two parts. The first of these is devoted to the question of stating existence theorems, that is to say, theorems which define the generality of functions that can be represented by a series of polynomials. This question is intimately related to the difficult problem of representing functions by means of FOURIER series, and to the broader problem of approximation by means of STURM-LIOUVILLE functions. The type of analysis thus invoked has been very attractive to mathematicians, and by far the greatest attention both in monograph and treatise has been devoted to it.

On the other hand, the problem of developing explicit formulas and practical methods of numerical approximation has been almost neglected. There are four phases of this problem. The first, and simplest, is that of representing functions by means of unweighted polynomials, the coefficients of the approximation being determined by integration. This is really the problem of the Legendrian polynomials, polynomials which possess the useful property of orthogonality. The second phase

is that of representing functions by means of weighted polynomials, the coefficients again being determined by integration. The LAGUERRE polynomials and the HERMITE polynomials both belong to this class, the latter in statistical literature being better known as the elements of the GRAM-CHARLIER series. The third and fourth phases concern the determination of approximations, by weighted and unweighted polynomials, over a range of *discrete points*. The first comprehensive study devoted to this subject was made by P. TCHEBYSHEV in 1858 and he continued his investigation in a second memoir in 1874. The theory was put into a more usable form by J. P. GRAM, who derived his inspiration from the work of TCHEBYSHEV, in a paper published in 1883, which, perhaps, has not received the general attention that it merits. It was not until 1899 that we find the first table computed to aid in the numerical evaluation of coefficients. This table was published by V. PARETO in the *Zeitschrift für Schweizerische Statistik*, but it has remained virtually unnoticed. Even SASULY has failed to mention it in a list of references, which is otherwise adequate and thorough.

KARL PEARSON entered the field in 1901 and was the first to emphasize the need for a systematic procedure for curve fitting. With the increased interest which developed in statistics during the first quarter of the present century, the need pointed out by PEARSON has been largely supplied. In fact, SASULY's book may be said to be the culmination of an extensive set of papers, which have provided the coefficients over a generous range for most of the important types of weighted and unweighted numerical approximation over discrete ranges. It is unfortunate that the author overlooked the paper by H. E. H. GREENLEAF, published in the *Annals of Mathematical Statistics* in 1932, which supplied coefficients for the approximation by polynomials weighted with binomial coefficients, the analogue for the discrete case of HERMITE polynomials.

With this orientation, we are now able to appraise the value of the book prepared by SASULY. It is obviously devoted to the third phase of the second problem, since the author states :

" The formal procedure for fitting polynomials by least squares has been available since the work of GAUSS and BESSEL. However, its utility was, until lately, seriously limited by the excessive labor entailed in the numerical solutions. The most fruitful research in recent years has been directed to the development of an effective technique to simplify the numerical computation steps... The primary purpose of the book is to derive formulas and computation schedules that will simplify as much as possible effective, practical trend analysis."

The author accomplishes his purpose very largely through numerical examples and carefully prepared outlines of the technical procedure.

Some attention is given to the basic theory of polynomial approximation, as one sees from his statement of the pertinent theorem of WEIERSTRASS, but the main function of the book is to provide a practical manual.

In addition to the classical methods, the author also develops techniques for fitting to statistical data moving polynomial arcs, which combine the advatages of polynomial trends and moving averages. In three appendices, the author provides 50 pages of useful tables.

The present book represents something of an innovation for the Brookings Institution, which has confined its publication largely to the field of the social sciences. It is hoped that the Institution may be inspired to publish other similar works. The book is beautifully printed and is a credit both to the Institution and to the author.

Indiana University. H. T. DAVIS.

P. A. M. Dirac.—*The Principles of Quantum Mechanics.* (Second edition.) xi+300 p. Oxford University Press, 1935. (Price $ 6.00.)

We have witnessed in the last ten years some of the most remarkable attempts in the history of science to explain the almost irrational behavior of nature. These explanations are now assembled under the generic title of the quantum theory. Beginning with the high authority of MAX PLANCK and ALBERT EINSTEIN as far back as 1900, this strange theory has been moulded by a group of brilliant thinkers into the imposing and curious edifice that now confronts us. One of the most prominent exponents of the theory has been P. A. M. DIRAC, Nobel prize winner in 1933, whose book, now in a second revised and enlarged edition, is before us for review.

The book comprises thirteen chapters : The Principle of Superposition, States and Observables, Representation Theory for Discrete Eigenvalues, Representation Theory for Continuous Eigenvalues, the Quantum Conditions, the Equations of Motion, Motion in a Central Field of Force, Perturbation Theory, Collision Problems, Systems Containing Several Similar Particles, Theory of Radiation, the Relativistic Theory of the Electron, and Field Theory. The present edition of the book is 40 pages longer than the first, the enlargement being mainly due to the introduction of new ideas. The largest addition is found in the concluding chapter, where the author essays the difficult task of providing a theory of quantum electrodynamics. The book has been mainly rewritten and gains considerable in clarity over the first edition, although the very nature of the subject makes the way murky at many places.

Let us now turn to a consideration of some of the difficulties encountered by the author. As is well known, the dilemma of radiation is the necessity

of reconciling a wave theory, as evidenced by polarization and diffraction, with a corpuscular theory, as evidenced by the phenomena connected with photo-electrons. DIRAC assumes the existence of a kind of observational zero, for he affirms that " there is a limit to the fineness of our powers of observation and the smallness of the accompanying disturbance—a limit which is inherent in the nature of things and can never be surpassed by improved technique or increased skill on the part of the observer." This, of course, is the postulate of the well known *principle of indeterminacy* announced in 1927 by W. HEISENBERG. As a result there exists a disturbance to the law of causality, since " if a system is small, we cannot observe it without producing a serious disturbance."

DIRAC defines a *state* of an atomic system to be the following : " A state of a system may be defined as a motion that is restricted by as many conditions or data as is possible without mutual disturbance or contradiction." Basic to his entire theory is what he calls the *general principle of superposition*, which applies to the states of any one dynamical system. " It requires us to assume that between these states there exist peculiar relationships such that whenever the system is definitely in one state we can consider it as being partly in each of two or more other states. The original state must be regarded as the result of a kind of *superposition* of two or more new states, in a way that cannot be conceived on classical ideas." The principle of superposition is invoked to show why photons can be polarized and diffracted. At this point language fails us. It would be more accurate to quote the author here, but the gist of his idea is as follows : If a photon is broken up into two components by an interferometer, it may be said to go partly into each component. But now let us make a determination of its energy. This very act of observation causes a profound alteration in the picture and " the photon must change suddenly from being partly in one beam and partly in the other to being entirely in one of the beams." One cannot predict into which beam the photon will go, but " only the probability of either result can be calculated from the previous distribution of the photon over the two beams."

These strange ideas have been reluctantly admitted by those physicists who demand models to guide their intuitions. A deep problem of epistemology is naturally invoked, the problem of deciding whether things can exist for which no rational concept exists. The experimental facts are incontestable, however, and in a dilemma of reconciliation between the clashing postulates of continuity on the one hand and discreteness on the other, the search has turned toward the discovery of mathematical equations which will lead to the proper numerical results

and predict new discoveries. The theory of DIRAC has certainly been successful to this extent, although it affords cold comfort to materialistic philosophers.

The author's principal mathematical tool is that of vectors and linear operators associated with them. This powerful tool is used by most writers on the subject, since it permits a free use of linear transformations and the theory of matrices. It may easily be generalized by means of integration so that it may include continuous as well as discontinuous spectra. A considerable amount of new symbolism is introduced, so that sometimes classical theories appear in new guise, but the ideas are mainly inherent in the general theory of linear operators as it has been developed by numerous mathematical writers. DIRAC was the first to introduce the convenient symbolism of the POISSON bracket and by this device he has succeeded in casting the theory of quantum mechanics into a form comparable with the mechanics of classical literature.

The habits of thought of the physicists have frequently worried mathematicians and the present book is not free from some criticism on this score. We take the following interesting example from chapter 4, where DIRAC says:

"The chief improper function which we shall have to deal with is the function, defined by

$$\int_{-\infty}^{\infty} \delta(x)\, dx = 1, \quad \delta(x) = 0 \text{ for } x \neq 0.$$

To get a picture of $\delta(x)$, take a function of the real variable x which vanishes everywhere except inside a small domain, of length say, ϵ, surrounding the origin $x = 0$, and which is so large inside this domain that its integral over this domain is unity."

This function is now freely referred to in the literature of quantum mechanics as "the DIRAC delta function." Few words of caution are found about its use and little if any reference is made as to its historical origin. This is rather a curious story. Impulse functions naturally arose very early in the theory of mechanics, but it was not until the publication of the HEAVISIDE calculus, the principal tool introduced by OLIVER HEAVISIDE in his *Electromagnetic Theory*, that the impulse function made its appearance as an operating device. Although this function was not explicitly stated in the DIRAC form by HEAVISIDE, it was certainly used implicitly by him throughout his work. There is no doubt that it appeared in the DIRAC form, and with greater rigor, prior to its introduction by DIRAC, as one may see by referring to the work by G. GIORGI: On the Functional Dependence of Physical

Variables. *Proc. of the International Congress of Mathematics*, Toronto, vol. 2 (1924), pp. 31-56. Since this function has been, and will doubtless continue to be, a very useful operational device in physics, it seems unfortunate to forget the impulse function of HEAVISIDE by substituting for it the delta function of DIRAC. Special care should be exercised on this point, since DIRAC was a fellow at the University of Cambridge, which in the beginning launched the most vigorous attack against the methods of HEAVISIDE. A comprehensive account of this subject will be found in a recent paper by W. E. SUMPNER : Impulse Functions. *Philosophical Magazine*, vol. 11 (7th series), 1931, pp. 345-368; the general usefulness of impulse functions is set forth in a table of FOURIER integrals published in 1931 by G. A. CAMPBELL and R. M. FOSTER.

An interesting example of the prediction of the results of physical experiment by mathematical methods should be pointed out. In the first edition of the book, DIRAC encountered certain negative values for the kinetic energy. In the interpretation of this situation he said : " We assume that these unoccupied negative-energy states are protons." This statement has been modified in the new edition to read : " We assume that these unoccupied negative-energy states are the positrons," where positrons are a new kind of particle having the mass of an electron but the opposite charge. Such particles were observed in the interval between the two editions and the prediction of their existence is claimed by proponents of the DIRAC theory.

The last chapter of the book is devoted to the task of providing a quantum electrodynamics, but the theory as there set forth possesses both the virtues and the flaws of classical electrodynamics. The author closes on the following note : " The limitations in the applicability of quantum electrodynamics thus correspond precisely to those of classical electrodynamics. The amendments required in classical theory in order to make it apply accurately to the elementary charged particles are thus not provided by the passage to the quantum theory, that is, by the taking into considerations of the disturbances accompanying measurements. It seems that some essentially new physical ideas are here needed."

Indiana University. H. T. DAVIS.

S. A. Mitchell.— *Eclipses of the Sun.* Fourth edition, revised and enlarged. XVIII+520 p., 9 figs., 80 pl. (4 in color), colored frontisp. New York, Columbia University Press, 1935. ($5.00).

The tracks of three total eclipses of the sun crossed the United States during the years of post-war prosperity and depression—on September 10, 1923, on January 24, 1925, and on August 31, 1932—temporarily arousing

public interest in eclipses. The first edition of *Eclipses of the Sun* was published in August, 1923, the second, in December, 1924, and the third, in August, 1932. This correlation between the eclipses and the publication dates may account for some of the defects of this carelessly edited standard volume in its field. A note printed on the verso of the title page of the fourth edition, now under review, informs the reader that chapters containing no out-of-date scientific statements have been reprinted without change from the third edition. The author, apparently, does not realize that a chapter containing no out-of-date statements may be in need of revision, if essential information, available at the time of publication of previous editions, has been omitted, and that a scientific statement may require revising or editing, not on account of its obsoleteness, but because it is objectionable regardless of the time when it is made; moreover, the note implies that the author is familiar with the up-to-date literature covering the chapters reprinted without change. These remarks apply specifically to chapters I to IX—pages 1 to 166—dealing with the history and theory of eclipses.

The author needs no introduction to American astronomers; other readers are advised to consult the latest edition of *Who's who in America*; they will find, at the end of his autobiographical sketch, the following autobibliography: "*Author*: Parallaxes of 260 Stars, 1920; Eclipses of the Sun, 1923, 4th edit., 1933; Parallaxes of 440 Stars, 1927; Fundamentals of Astronomy (with C. G. ABBOT), 1927; Solar Eclipses, 1929." It might be added that the textbook is based on "The earth and the stars," by C. G. ABBOT; that OLIVIER, ALDEN and others assisted the author, in the case of the first parallax publication, and were joint authors, in the case of the second parallax publication; that the 1929 book on eclipses is not listed in the catalogue of the Library of Congress; and, finally, that the wrong date, 1933, is either a misprint or an indication of a delay in the publication of the fourth edition of *Eclipses of the Sun*, to which we presently return.

A collation of the pages 1 to 166 of the fourth edition with the corresponding pages of the previous editions reveals the fact that 142 pages —more than 85 per cent,—set up and electrotyped in 1923, have never been revised; 5 pages have been slightly revised and then electrotyped in 1924, and 11 pages, in 1932; the remaining 8 pages (p. 54-61) have been revised for the fourth edition, but the major part of the text of these pages has been inherited from the first edition, including such statements as "... it is possible for there to be three eclipses of the moon within the calendar year..." (p. 59).

The first half of the fourth edition (chapters I to XIII) deals with the history, mechanics, statistics, description, and observation of eclipses;

the second half (chapters XIV to XXV) gives a popular account of atomic and solar physics, of relativity, and related matters; the present reviewer is not qualified to pass judgment on the accuracy and up-to-dateness of the information offered by the second part of the book. The chapters X to XIII and parts of chapter XXV are devoted to the personal experiences of the author who " traveled ninety thousand miles to witness nine total eclipses of the sun " (p. XVII); he hopes to be able to observe, in 1936, " his tenth eclipse when he will have accomplished the rare feat of observing three total eclipses in the same series separated by the Saros interval of 18 years 11 days " (p. 61). He compares, on pages XVI and XVII, the life of an eclipse observer with the life of a big game hunter. It might be added that big game hunters are seldom interested in zoology, not to mention the history of zoology; when they write books, they are not supposed to waste several chapters on matters which are outside their sphere of interest and competence. Books on eclipse hunting, on the other hand, must contain introductory chapters dealing with the history, mechanics, and statistics of eclipses; the book under review proves that an experienced observer of total eclipses is not necessarily qualified to write such introductory chapters.

The author, apparently, is not familiar with Maya astronomy in general, and with the Dresden Codex in particular. MEINSHAUSEN's paper, interpreting the pages 51 to 58 of the Dresden Codex as a table of ecliptic syzygies, appeared in 1913, ten years before the first edition of *Eclipses of the Sun*; GUTHE's and WILLSON's contributions appeared in 1921 and 1924, respectively. The book under review does not mention Maya astronomy. The author tells, on page 167, " as an illustration of how little the average European knows about America," an after-dinner story about a European astronomer unfamiliar with the fact that the wild natives of North Carolina have been exterminated. How much—or how little—does the author know about American Indians, especially about the Maya who have succeeded in constructing a table of ecliptic syzygies based on observations made in a small isolated tropical area seldom reached by partial solar eclipses?

Due to the awkward grouping of the subject matter, Babylonian eclipses are dealt with both in chapter I, Early historical eclipses, and in chapter II, Biblical and classical eclipses. Many pages are wasted on irrelevant matter " which is of the greatest of interest to all Christian peoples" (p. 29; similar apology on p. 13), but the author never mentions the names of NABURI'ANNU and KIDINNU. It is safe to assume that he is not familiar with their contributions to astronomy; if he should be interested in their researches on the motion of the moon, he may consult pages 41 to 50 of ZINNER's *Geschichte der Sternkunde*;

incidentally, ZINNER's book was available at the time of the publication of the third edition.

The book under review begins with Chinese eclipses, and more than eight pages are devoted to them. Five of these eight pages are wasted on HSI and HO, and on the chronologically worthless eclipse of October 22, 2137 B.C. More than a page is wasted on CONFUCIUS and his relatives. Concerning the eclipse of September 6, 776 B.C., the author says: "The evidence of this eclipse is indisputable; it fixes absolutely without controversy the first certain date in the history of China" (p. 8); this is, apparently, an echo of LEGGE's "the earliest date in Chinese history about which there can be no dispute;" W. HARTNER has recently shown (*T'oung Pao*, 31, 188-236, 1935) that the eclipse of November 30, 735 B.C. has a better claim to the distinction of being the *Shih-ching* eclipse. The space wasted on anecdotes and other irrelevant matter was sufficient for a brief survey of Chinese astronomy and, of course, for a readable account on Chinese eclipses. The author may consult, for the benefit of the readers of the next edition, L. DE SAUSSURE's papers and HOANG's catalogue of Chinese eclipses. The patronizing attitude of the author toward the Chinese is, probably, due to his superficial acquaintance with Chinese civilization.

Before we pass to the seven pages supposedly dealing with Egyptian astronomy, we must call the reader's attention to an annoying feature of the early chapters of all four editions. In the early stages of the writing of this book, the author, apparently, intended to subdivide the chapters into sections; subtitles of some of these rudimentary sections have survived in the chapters I, II, and IV; thus, "Other Chinese Eclipses" was, apparently, intended to correspond to the missing subtitle, "Early Chinese Eclipses;" a subtitle like "Eclipse of Thales" covers too much ground, because the subtitles of the succeeding sections were omitted. These abortive subtitles, set up both in small capitals and in the type reserved for chapter titles, have been electrotyped in 1923, and have, therefore, remained unchanged in all "revisions." Other examples of editorial carelessness will be quoted at the end of this review.

Let us pass to the section bearing the subtitle "Egyptian Astronomy." The acknowledged source of the author's information concerning Egyptian chronology is HAMLIN's article in the *Encyclopedia Americana*, vol. 10, page 12; the author neglected to add that HAMLIN's article deals with Egyptian architecture. The section on Egyptian astronomy is filled with irrelevant and unreliable historical, architectural, and archaeological information. TUT-ANKH-AMEN's *merkhet* is not the "oldest astronomical instrument in the world" (p. 25); similar instruments from the time of TUTHMOSE III and of AMENOPHIS III are older;

so is the clepsydra of Karnak; suggested reading: BORCHARDT's *Altaegyptische Zeitmessung*, published in 1920. The author states that the Egyptians "must have possessed knowledge of surveying vastly greater than is shown by any written record" (p. 23); is he familiar with the epigraphic records of the ceremonial plotting of the meridian in the temples of Abu Gurab (end of the fourth millennium) and of Amada (middle of the second millennium)? "If we are to judge of the accomplishments of the Egyptians by the written documents alone, we must assume that they knew little and cared less for any branch of science" (p. 22); is the author familiar with the mathematical and medical papyri? Facing page 24 of all four editions is a plate bearing the caption, "An Ancient Egyptian Calendar;" no reference to the plate can be found in the text of the four editions; no source is indicated in the index of illustrations; to the readers—as well as to the author—the plate was merely an inserted pretty picture, supplying local color. The reviewer hereby informs the author that the plate facing page 24 of his book represents the columns 19 to 38 of the diagonal calendar on the coffin lid of AASHAIT; cf. col. 1 to 19, *Bull. M. M. A.*, 16, Pt. II, Fig. 24, 1921; the stellar diagonal calendar has, of course, nothing to do with the lunar calendar or with eclipses; it merely illustrates the attempts of the Asyutians of the end of the third millennium to correlate the hours of the night with the seasonal changes in the time of rising of the decans; it is just a diagram recording, in rectangular coordinates, the results of systematic astronomical observations. "The Egyptians were not interested in systematized observations" (p. 26), says the author.

The following remark may serve as an illustration of the author's acquaintance with Greek astronomy: "To PLATO (428-347 B.C.) astronomy owes but little, he even going so far as to decry, as degrading, the observation of the heavenly bodies." (p. 37-38). How little astronomy owes to PLATO may be expressed, statistically, by the following statement: his name is mentioned by ZINNER on fifteen different pages, and no less than thirty pages of Sir THOMAS HEATH's *Greek Astronomy* are devoted to the astronomical passages in PLATO's writings and to their discussion. The author managed to discuss the eclipses of classical antiquity without mentioning GINZEL's *Spezieller Kanon*.

The author is not interested in mediaeval eclipses; he makes, however, the following curious statement: "It is but natural that the prehistoric superstition of the dragon swallowing the sun should have spread during the middle ages from the far East to all of the civilized world" (p. 131). He does not mention SCHROETER's *Spezieller Kanon*. In connection with the total eclipse of May 3, 1715, he states: "It can be said with certainty that not a single total eclipse of the sun had visited London

for 600 years previous to 1715" (p. 128); an inspection of SCHROETER's maps shows that London remained outside the tracks of totality since the eclipse of October 29, 878.

Let us pass from these specimens of the author's historical erudition to his mechanics and statistics of eclipses. "The diameter of the so-called negative shadow may be as great as 230 miles. Since the maximum width of the shadow causing a total solar eclipse is only 163 miles, it is evident that the number of annular eclipses are more frequent than total —only two out of five central eclipses being total." (p. 44). The author is not discussing the probability, for a given station, of being included in the path of the annulus or in the tracks of totality. He is making a statement concerning the relative frequency of the two principal kinds of umbral eclipses, the annular and the total. The umbra can reach the earth's surface—and a total or annular-total eclipse may take place—if the umbra is sufficiently long and the moon is sufficiently near; if these conditions are not satisfied, the apex of the umbra will fail to reach the earth, and the eclipse will be annular. A statistical survey of OPPOLZER's eclipses shows that 42.8 per cent of all umbral eclipses are total, 6.8 per cent are annular-total, and 50.4 per cent are annular; eclipses in which the umbra reaches the surface of the earth constitute, therefore, 49.6 per cent of all umbral eclipses—in other words, they are almost as frequent as eclipses caused by the extension of the umbra beyond its apex; most of the annular-total eclipses are unsuitable for heliophysical observations, and it is, therefore, customary to count them as annular eclipses and to say that two out of five central eclipses are total. The 2:3 ratio between the maximum widths of the tracks of totality and of the path of the annulus is not the cause of the 2:3 ratio between the number of total eclipses and the number of annular and annular-total eclipses.

The author states, on page 52, that a solar saros series contains "from 68 to 75 solar eclipses," extends "over some 1200 years," and consists of "approximately 25 partial eclipses and 45 central eclipses." Statistical investigations, based on OPPOLZER's *Canon der Finsternisse*, show that a solar saros series may contain from 70 to 85 eclipses; the duration varies, therefore, between 1244 and 1514 years; the number of umbral eclipses of a solar saros series varies between 39 and 59. No solar saros series containing 68 or 69 eclipses are known to this reviewer.

"On account of the ecliptic limits for lunar eclipses being smaller in value than for solar eclipses, there will be fewer repetitions in a lunar series, there being 48 or 49 altogether. Of this number there will be 22 or 23 total, with 13 or 14 partial eclipses, both before and after the total eclipses. The interval for a series of lunar eclipses consumes

about 870 years " (p. 52). Statistics based on OPPOLZER show that the number of umbral eclipses in a lunar saros series may vary between 39 and 59, as in the case of the umbral runs of solar saros series ; the duration of an umbral run—lunar or solar—varies between 685 and 1042 years; the number of total eclipses of a lunar saros series may be as low as 11 or as high as 30.

On page 60, the author states that the next calendar year with five solar and two lunar eclipses will be the year 2485 ; this statement has been often repeated, during the current seven-eclipse year, by writers of popular articles on science. The Gregorian calendar year 2391 will have five solar and two lunar eclipses, if the penumbra of the moon should reach the surface of the earth during the ecliptic syzygies of January 6 and August 1 ; otherwise, the year 2456 would be the next to be considered. Five solar eclipses cannot occur in the year 2485.

The author mentions, on page 32, a best seller in the field of belles lettres which contained—horribile dictu— "no less than four astronomical blunders." Astronomical best sellers contain, occasionally, more than four astronomical blunders.

In addition to a considerable number of misleading statements based on the author's superficial acquaintance with eclipse mechanics and statistics, there are numerous statements which are objectionable on account of his unscientific use of the expression " total," when applied to solar eclipses. It is customary to use the designation " central " instead of " umbral," in connection with solar eclipses ; since 98.7 per cent of all umbral solar eclipses are central, the two designations may be used promiscuously, in the majority of cases. There is, however, no excuse for the use of the term " total " instead of " umbral " or " central "; an eclipse hunter may despise annular and annular-total eclipses, as a big game hunter may despise ordinary game,—he must face the fact that such eclipses not only exist but constitute the majority of umbral or central eclipses. Numerous statements on pages 47 to 50, and occasional statements elsewhere, containing the term " total," in connection with solar eclipses, are, therefore, unscientific, and may mislead the innocent reader ; on the same pages, the term " total " is correctly used, in connection with lunar eclipses, adding to the confusion. The tabulations on pages 48 and 50 seem to link partial solar with partial lunar eclipses, and total solar with total lunar eclipses.

Lack of precision in statements and definitions is to be expected in a popular book ; it seems to the reviewer that some of the expressions used by the author are out of place even in a popular book ; when the author decides, occasionally, to be precise in his scientific statements, he uses awkward expressions ; here are a few examples :

Quotations	*Suggestions*
" ... the length of a revolution from the position of perigee to perigee in the moon's orbit " (p. 40).	... the duration of a revolution of the moon in its orbit, from perigee to perigee.
" ... and assuming C as the length of the moon's radius, and D the distance from centers of sun to moon " (p. 43).	. . . . and D as the distance between the centers of the sun and of the moon.
" Away from the equator, farther north and south in latitude, the speed is progressively less at greater and greater distances from the equator..." (p. 45)	The speed decreases in higher latitudes...

No specific suggestions are offered by the reviewer for the improvement of such passages as " ... whether the moon is sufficiently near enough to the plane of the ecliptic for her to come between earth and sun " (p. 41), or "... this is the speed that the moon's shadow passes across the earth..." (p. 45). Expressions of this kind are evenly distributed throughout the book.

Let us look at the plates and at the index. Chapter X, devoted to the personal experiences of the author in Sumatra, begins on the electrotyped page 167 in all four editions, and marks the beginning of the enlarged and revised portion of the book. The text of the first edition ends on page 419; in the fourth edition, it ends on page 511; there were 59 plates, including the frontispiece, in the first edition; in the fourth, there are 81 plates; they are not numbered. Some confusion was to be expected. Thus, when we find, on page 202 of the fourth edition, a reference to a plate " facing page 204," we know that the frontispiece is meant; and when we find, in the same sentence, a reference to the frontispiece, we know that the author really means the plate facing page 224; the additional misprint—204 instead of 224—was inherited, via electrotype, from the third edition. Again, when we find, on page 131, a reference to a plate " facing page 130," we know that the author means the plate facing page 128; the page 131 was set up and electrotyped in 1923, its bottom, where the reference occurs, was reset in 1924, and the reference became misleading in the third edition. On the erratum slip following the plate facing page 373, there is a misprint: instead of " facing pages 8 and 13," read " plates facing pages 8 and 13." There is a misprint in the caption of the plate facing page 52: instead of " July 12, 1211," read " June 12, 1211." The caption, " East Indians in Picturesque Garbs," on the plate facing page 177, ought to be changed to " Sumatrans in Picturesque Garb;" incidentally, the reproduction of a cylindrical lunar calendar of the Toba-Battak would have been

a more appropriate method of supplying local color than the insertion of snapshots of a Sumatran beauty and of a Sumatran mother with her half-caste daughters.

The index is incomplete. Thus, the names of FABRICIUS and SCHEINER are missing in the index; on page 118 these two discoverers of sun spots are mentioned, along with GALILEO; GALILEO is mentioned in the index, not on account of the sun spots, but because his name appears, on page 423, in a general statement including COPERNICUS, TYCHO, KEPLER, and NEWTON. Again, the names of the early observers of the flash spectrum are mentioned on page 142 but not included in the index; YOUNG is mentioned in the index, but not in connection with page 142. Proper names appearing on several pages picked at random were not found in the index. There are, of course, errors in the index due to changes in pagination.

The reviewer hopes that the fifth edition will be not only thoroughly revised but also carefully edited and indexed, and that the investment represented by the text set up in 1923 will be written off at its scrap-metal value; the manufacturing of electrotypes should not be permitted to become, in a way, a durable goods industry.

ALEXANDER POGO.

J. R. Partington.—*Origins and Development of Applied Chemistry*. LONGMANS, GREEN AND CO., London, New York, Toronto, 1935. XII+597 pages (45 shillings net).

In the present work Professor PARTINGTON has attempted something which is entirely new and has succeeded admirably in doing it. The book is a history of pre-science. It does indeed discuss to the fullest possible extent the origins and early development of applied chemistry, but the book contains much more than its title indicates. It deals primarily with the chemical practices of the ancients which may be deduced from the findings of archeology, with the materials which the ancients used for all purposes, hence with the sources of these materials, and hence with the trade relations, wars, etc., which occurred among the various peoples. The book in short is a history of the archeological period from 4000 or 3000 B. C. to about the beginning of the Christian era, based largely upon the findings of the archeologists and concerned chiefly with the materials which were in use, how they were used and for what purposes, a history of culture in the sense that it supplies an account of what the ancient peoples were doing.

The author says in the Preface:

> When the growth of an idea, or the perfection of some technical process, is traced backwards in time, a point is often reached when the development

leaves the track of formal science, and enters the wide and often ill-charted territory of the general achievement of man. For this reason, a balanced and just appreciation of the history of science can be attained only when a complete and critical survey of its earliest origins is available. This is always a matter of considerable difficulty, and in the case of such a science as Chemistry it is particularly so, since the first narrow and ill-defined track led from that vast territory of endeavor which comprised the use by man from the most remote period of all kinds of materials...

One important result of this survey, which could hardly have become clear without it, is the realization that the knowledge of the use of materials in the Classical Period, which usually forms the starting-point for the historian of science, is almost wholly derived from much older cultures. It represents in many cases, not an original and vigorous development of national genius, but a decadent form of craftsmanship which had existed for a period often as long as that which now separates us from the best days of Greece and Rome. Just as the modern industrial period has ruined the traditions of craftsmanship, so the irruption of the people of the Iron Age broke the continuity in a traditional use of materials which had developed almost without a break from the period of the Stone Age. The essential methods nevertheless continued with little alteration, as in some cases, such as the art of the potter, they do to the present day. In the study of the development of man no part is more significant, even if more neglected, than that concerned with the use of materials.

It was considered desirable to give brief accounts of the general history and archeology of the regions concerned, since although these can be found in standard works of reference, many of these are now incomplete and even innacurate by reason of the rapid progress made in recent years. This great advance in knowledge made it necessary to rewrite many of the sections more than once, and as the preparation naturally extended over a period of years, some difficulty was experienced in keeping the whole work up-to-date in all its sections... In these general sections particular attention is given to the relations between the various centers of civilization, and although an adequate account of ancient trade written by a specialist is lacking, an attempt has been made to indicate some possibilities in this field...

In dealing with the information from very varied sources, those statements and hypotheses which are not possible from the point of view of the chemist have been corrected, usually without special mention, except in a few cases where it seemed desirable to draw attention to common errors which are repeated.

The book contains about 7000 numbered footnote references, each usually containing more than one citation, or about 25000 literature references altogether. It is equiped with an Index of Authors and Publications, an Index of Persons and Nations, an Index of Places, a Subject Index, and a Greek Index.

The book is divided into sections which deal respectively with Egypt; Babylonia and Assyria; Aegean Civilization, Troy and Cyprus; Asia Minor; Persia; Phoenicia; and Palestine. Professor PARTINGTON says that he had at first intended to include sections on India and China but abandoned the intention " after much material had been collected,

partly because these regions in some way lie apart from the rest of the world in their technical processes, but more particularly because the information at present available seemed insufficient as compared with that for the other regions." The section on Egypt is by far the longest. It is put together in a manner which is similar, subject to the availability of material, to that in which the other sections are composed. A detailed account of its contents will convey a clearer idea of the nature of the book. It consists of three parts: I. General; II. Metals; III. Non-Metals. The first of these is subdivided into portions headed: Chronology; Prehistoric Egypt; The Thinite Period; The Old Kingdom; The Middle Kingdom; The New Kingdom. The second, on Metals, is divided into 1. Precious Metals (and Gems), subdivided into portions headed The Metals in Egypt; Temple Workshops and Libraries; Libraries in Egypt; Labour and Crafts; The Production and Use of Fire; Fuel; Blowpipe and Bellows; The Discovery of Metals; Gold; Predynastic and Early Gold; Middle and New Kingdom Gold Work; Composition of Egyptian Gold; Varieties of Gold; Goldsmith's Work; Weights and Measures; Sources of Egyptian Gold; Egyptian Gold Mining; Stocks of Gold; Asem (Elektron, Electrum); Composition of Electrum; Silver; Chesbet; Mafek; Gems—and 2. The Useful Metals, subdivided into portions headed Copper; The Earliest Copper in Egypt; Old Kingdom Copper; Some Analyses of Early Copper; The Discovery of Copper; Sources of Copper; Egyptian Mining in the Sinai Peninsula; African Copper; The Egyptian Coppersmith's Work; Hardening of Copper; Bronze; Method of Making Bronze; The Oldest Bronze in Egypt; Analyses of Egyptian Bronzes; Objects of Bronze; Tinned Copper; The Discovery of Bronze; Sources of Egyptian Tin; African Tin; Tin; Lead; Brass and Zinc; Antimony; Mercury; Platinum Metals; Iron; The Names and Representations of Iron; Sources of Iron; Predynastic Iron in Egypt; Egyptian Specimens of Iron; Steel; African Iron. The third part, on Non-Metals, is divided into three parts, namely, 1. Stone, Ceramics and Glass, Pigments, subdivided into portions headed Stone; Plaster and Stucco; Bricks; Pottery; Black-Topped Pottery; Glaze and Glazed Ware; Colours of Glaze; Egyptian Blue; Glass; Early Glass in Egypt; Old Kingdom Glass; Middle Kingdom Glass; New Kingdom Glass; Later Glass; The Egyptian Glass Industry; Gilt Glass; Colourless Glass; Blowing Glass; Analyses of Egyptian Glasses; Imitation Gems; Vasa Murrina; Enamel; Pigments; Analyses of Pigments; Sources and Composition of Pigments; Use of Pigments, Media; Encaustic Painting; Eye Paint, —2. Non-Metallic Materials, subdivided into portions headed Salt; Natron; Sal Ammoniac; Alum; Sulphur; Nitre (Salpetre),—and 3.

Organic Materials, subdivided into portions headed Textiles; Dyes and Dyeing; Pomade and Ointment; Plant Products; Oils; Manna; Incense and Perfumes; Frankincense and Myrrh; Other Kinds of Incense; Kyphi; The Mummy; Materials Used in Embalming; Egyptian Medicine; Egyptian Physicians; Physicians and Priests; Imhotep; Magic in Medicine; Medical Texts; The Egyptian Medical and Surgical Papyri; The Ebers Papyrus; The Hearst Papyrus; Egyptian Surgery; The Edwin Smith Surgical Papyrus; The London Papyrus; The Berlin Papyrus; The Coptic and Greek Medical Papyri; Woods; Drinks; Beer; Vinegar; Wine; Bread; Leather; Detergents; Ivory; Various Animal Products; Writing Materials; Ink.

PARTINGTON's book is a work of the first magnitude, one that may some day perhaps be revised or enlarged but one that need never be rewritten. It will be indispensable to the student of the history of chemistry and to the student of the history of science and culture. The archeologist will wish to take a copy of it with him to the site of his excavations. The great museums of the world will not wish to get along without it. The student of economics will be interested in the weight and relative value of the ancient coins, in the gold-silver ratio among the various nations at various times, in the effect of ALEXANDER's conquests upon it, and in the two dark ages of ancient Egypt concerning one of which a text says that "irrigation was neglected, trade was at a standstill, and cedar wood, grain, gold and charcoal were lacking." The teacher of chemistry will find in the book much material for use in his classes—for example, the hard copper of the Egyptians produced by "under-poling" and deriving its hardness from the cuprous oxide which it contained, or the use of alum for the fireproofing of wooden construction.

The book is expensive ($16.50 in the United States), but probably worth it on the basis of the present price of books. The print job is difficult and well done. There are a few inconsistencies in the spelling of oriental words, arising out of differences in usage among the authorities who are cited, but we have found no typographical errors.

TENNEY L. DAVIS.

Conway Zirkle.—*The beginnings of plant hybridization.* XIII+231 p., 8 pl. Philadelphia, University of Pennsylvania Press, 1935 ($2.50).

Our readers should be already familiar with ZIRKLE's discoveries of early documents concerning hybridization because we devoted very long notes to his publications of 1932 (*Isis* 21, 218-20) and 1934 (*Isis* 22, 605). In addition they have learned to know him and to appreciate his

learning because of the curious study on " Animals impregnated by the wind " which it was our privilege to publish (vol. 25, 95-130, 1936).

The present volume, very handsomely got up for the Morris Arboretum where the author is employed as geneticist, is a revised and enlarged edition of his earlier papers. Thanks to his investigations, the relevant chapter of SACHS's history is proved to be completely insufficient. Of course this is what the experienced historian fully expects. Whenever a specialist starts the historical investigation of his own field he is almost bound to discover facts which the earliest historian exploring a larger field had neglected, and that is especially true when the specialist is endowed with as much inquisitiveness and is as good a detective as the author of the present volume.

The scope of ZIRKLE's book will be best indicated by means of extracts from his own preface :

" The numerous contributions of the earlier plant breeders have never been collected or made available to modern geneticists. Even ROBERTS, who traced so clearly the development of pre-Mendelian genetics in his *Plant hybridization before* MENDEL, paid little attention to the hybridizers who preceded KOELREUTER although he did describe the work of RICHARD BRADLEY in addition to those hybridization experiments mentioned by SACHS. WEATHERWAX (1923) noted the observations of PAUL DUDLEY, and several modern authors have referred to PHILIP MILLER's account of hybrid cabbages but the other plant hybridizers who labored before the middle of the eighteenth century have been ignored. Today the fact is generally unknown that plant hybrids had been made and observed for forty-five years when KOELREUTER undertook his classic experiments, and that many of these early observations had been reported with commendable care. Some few of these early investigators designed and executed their experiments as scientifically as did KOELREUTER himself, and although many of them were extremely casual and did not bother to check their results or verify their speculations, a considerable knowledge of plant hybridization had accumulated by 1760. In the following pages I have included all of the discussions of plant hybrids before 1761 which I have been able to find..." " The works are quoted in full, regardless of their merits, for most of them are in publications not available to the majority of geneticists. Some of these discussions of hybridity are intrinsically worthless, yet it is essential that we know of them if we are to understand the scientific standards of the early eighteenth century and appreciate the background of those investigators who gave us our first real knowledge of plant hybrids."

The study is completed with a chronological list of hybridization from 1716 to 1760 (a revision of the list which may be read in *Isis* 21, 218-20), an elaborate bibliography, four portraits and other illustrations.

GEORGE SARTON.

Johan Nordström.—*De Yverbornes Ö. Sextonhundratalsstudier*. 197 pages. ALBERT BONNIER, Stockholm, 1934.

This well printed volume contains four papers previously published. They are presented in slightly modified form. *Lejonet från Norden* was originally published in 1932, and with additional notes in 1934; *Götisk historieromantik* was published in 1931 ; the address on *Gustavus Adolphus* in 1932, and *De Yverbornes Ö* in 1930.

In *Lejonet från Norden* (*The Lion of the North*) is traced the development of the idea, well established in Germany prior to the battle of Breitenfeld, where GUSTAVUS ADOLPHUS was victorious over TILLY, that a champion for the Protestant cause would come out of the North. During the years previous to the landing of GUSTAVUS ADOLPHUS in Germany his victories in other quarters had led to the widespread belief that he was the expected lion from the North. His subsequent victories strengthened this belief.

According to NORDSTRÖM the present age has little conception of the world in which GUSTAVUS ADOLPHUS lived. Natural science has entirely changed our conceptions of the Universe, and the Christian religion of today is entirely different in essential aspects from that of the age of the Reformation, when Biblical prophecy was considered the guide of life. This situation prepared the way for reception of a prophecy of PARACELSUS to the effect that a golden lion from the North should be victorious over the imperial eagle of Rome and after that should come the last day. This prophecy began to be circulated about 1546 or 1549, although PARACELSUS died in 1541. The earliest known published account is dated 1622. It became the fountain of inspiration for the belief that a God-sent champion would appear. This idea was supported by passages from the Old Testament, by dreams, by astrological interpretations and by various publications. In the early 17th century it was spread by tracts and pamphlets, some with illustrations showing the golden lion. A number of these illustrations are reproduced in the text of the present volume. Gradually the prophecy of PARACELSUS and the revelations and dreams of others centered about GUSTAVUS ADOLPHUS as the lion who was to overcome the Roman eagle and free the world. After the death of the king at the battle of Lützen (1632) the conception of the Lion of the North was transferred to his kingdom.

The paper recites, not the history of science, but the history of an idea which played an important part in its day. That baffling figure of chemistry and medicine, PARACELSUS, is also thrown into another relief.

Götisk historieromantik och stormaktidens anda (*The history-tradition of the Goths and the spirit of the period of Swedish imperialism*). No idea in former times had a deeper influence on the Swedish viewpoint of history and on Swedish patriotism than the proud knowledge that

they were of the same blood as the Gothic warriors, who, issuing forth from Scandinavia, overran Europe, conquered Rome and founded strong dominions on the ruins of the fallen empire. For many centuries this age of giants stood forth in Swedish thought as the highest expression of the manhood and strength of the race. It provided powerful and stimulating ideas which played an important part in the country's history. This Gothic inheritance produced in Sweden a feeling that the country occupied a unique place among the nations. The spirit of the period of empire is permeated by the Gothic tradition, and its dominance increased as the great events of this period seemed to fulfill the aspirations for power. In this light a new point of view is given to the period of GUSTAVUS ADOLPHUS which helps us to understand the play of phantasy in the progress of history. This Gothic patriotism stands out as the fully developed inspiration of the nation's life. Its development is followed in this study.

Tal vid Gustav Adolfsfesten (*Memorial address on Gustavus Adolphus*) at Uppsala, November 5, 1932.

An interpretation of GUSTAVUS ADOLPHUS and his time.

De Yverbornes Ö, till Atlanticans förhistoria (*The Hyperborean Isle, the background of the Atlantican*). The author states that the *Atlantican* of RUDBECK is perhaps the most remarkable work of Swedish literary scholarship. Its name is known to all, but few in these days have held its mighty tomes in their hands or looked into its pages. In this study NORDSTRÖM traces the genesis of the ideas which led RUDBECK, in the days of Sweden's world power, to his great undertaking of trying to demonstrate that his land was the mother of all Europe and its culture. The writings of JORDANES, OLAUS and JOHANNES MAGNUS, BUREAUS, ADAM OF BREMEN and many others, contain numerous passages foreshadowing the thesis which RUDBECK was to develop. The idea was not new in RUDBECK's time that the Hyperborean isles were Scandinavia. "If they are not fools they can now see that Hyperborea is in Scandia" wrote BUREAUS before RUDBECK, as a result of his own studies. RUDBECK vigorously undertook to show exhaustively that his land had been the mother of Europe, and furthermore, that it was the lost Atlantis of PLATO. NORDSTRÖM traces the Hyperborean tradition which was the foundation of RUDBECK's antiquarian investigations, by which RUDBECK would show his countrymen the road to the Hyperborean Isle, the road "which for 3 or 4000 years has been overgrown with tremendously large and tall trees."

University of Oregon Medical School, Portland.

O. LARSELL.

Sylvanus G. Morley.—*Guide book to the ruins of Quirigua.* viii+205 p., 48 fig. Washington, Carnegie Institution, 1935. (75 cts. unbound; $1.25 cloth bound).

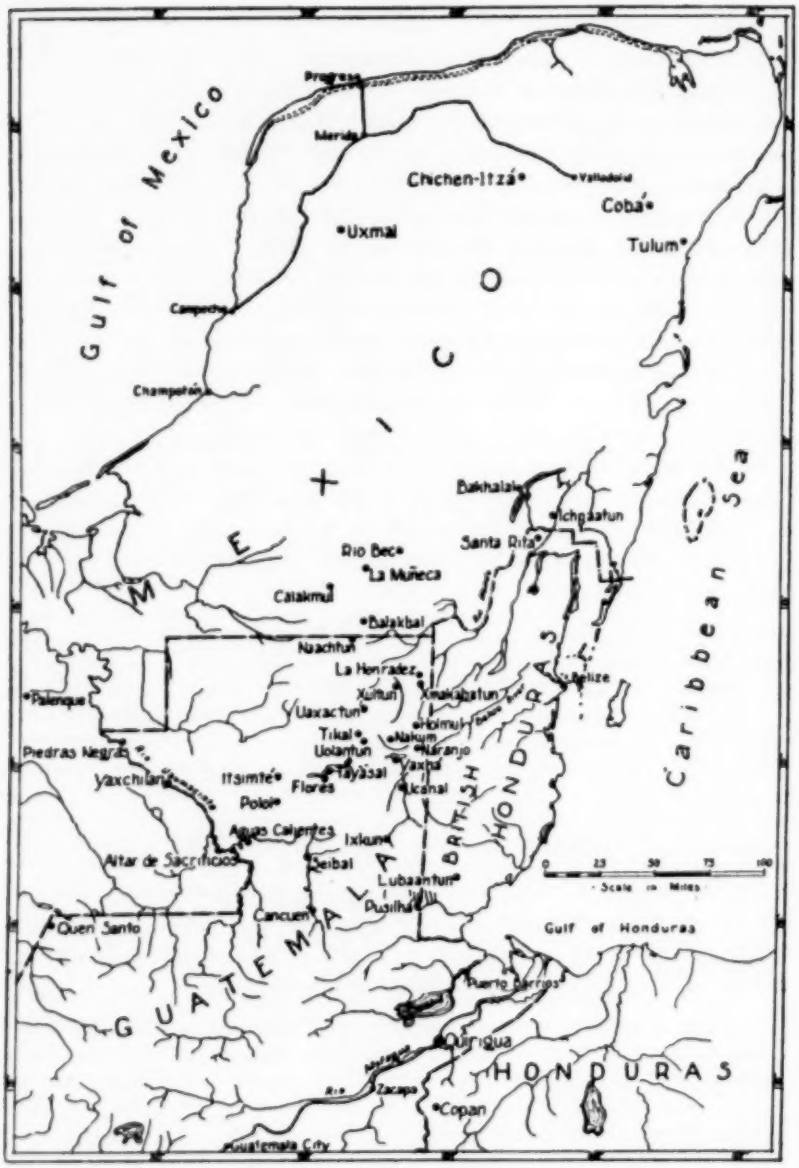
Dr. MORLEY's fundamental investigations of Maya archaeology have often been mentioned or discussed in *Isis*. See, e.g., the review of his *Inscriptions at Copan* (Washington, 1920; *Isis* 3, 292-4). (1) For a list of his other publications apply to the Carnegie Institution of Washington. The present little volume is a very modest but excellent guide to the ruins of Quirigua (in the eastern part of Guatemala, about 60 miles from the harbor of Puerto Barrios on the Gulf of Honduras). These ruins were discovered about 1840 but their scientific study was begun only in 1881 by the great English archaeologist, ALFRED PERCIVAL MAUDSLAY (b. 1850); that study has been continued by a number of American archaeologists, the leading one being MORLEY himself. The oldest known Maya site, Uaxactun in northern Guatemala, discovered by MORLEY in 1916, dates probably from the IVth century of our era; from Uaxactun the culture of the Old Maya Empire spread to other centers such as Copan, later still to Quirigua (end of VIIth century) and the Quirigua period corresponds to the golden age of that culture. The decline began in the IXth century; it was probably due to an agricultural collapse.

" If *milpa* agriculture is continuously practiced in any region, however well-forested it originally may have been, eventually the repeated clearing and burning will destroy not only the forests themselves, but also the rich humus which has supported them. Grass gradually replaces woody undergrowth until there comes a time when only grass returns after burning and the forests are no more. When this condition becomes general, *milpa* agriculture is at an end, since, as already explained, the ancient Maya had no tools with which to turn the sod. Either they had to move to still forested regions which they could cultivate, or starve to death—a stern alternative there was no escaping, and so they moved." (p. 37).

In addition to a clear description of the Quirigua ruins, MORLEY's guide contains a brief account of Maya culture, of their hieroglyphic writing, arithmetic, and astronomy, and a bibliography. I wish to quote his final appraisal of the Maya achievement :

" In appraising the civilization of any people, the true measure of their attainment is not the sum total of their achievement compared with the achievements of other peoples, but rather their entire accomplishment counted from their own cultural zero. Thus the construction of the Empire State Building with all the mechanical devices, modern machinery and building materials available to its builders is much less an achievement than the erection of a Maya temple of far less size and complexity, but built entirely without metal tools, structural steel, cement,

(1) That review contains a brief history of Maya archaeology.



Archæological Map of the Maya Area.

hollow tile, machine-sawn and dressed stone, compressed air, electricity, gas, steam and elaborate hoisting machinery. The former was built with the knowledge of the ages behind its builders; the latter without metal, tools, beasts of burden, either animate or inanimate, or even knowledge of the principle of the wheel. To find a condition in the Old World comparable to the Maya cultural scratch, it is necessary to go far back in human history to early Neolithic times when man's knowledge and utensils were similarly restricted. On this primitive horizon only may the Maya Civilization be fairly compared with other civilizations of antiquity both in the Old World and in the New.

When the material achievements of the ancient Maya in architecture, sculpture, ceramics, the lapidary art, feather-work, cotton-weaving and dyeing are added to their abstract intellectual achievements—invention of positional mathematics with its concomitant development of zero, construction of an elaborate chronology with a fixed starting point, use of a time-count as accurate as our own Gregorian Calendar, knowledge of astronomy superior to that of the ancient Egyptians and Babylonians—and the whole judged in the light of their known cultural limitations, which were on a par with those of the early Neolithic Age in the Old World, we may acclaim them, without fear of successful contradiction, the most brilliant aboriginal people on this planet" (p. 41-42).

The guide is beautifully illustrated, and very satisfying in every way, except the lack of an index and of a table of concordance between Maya and Gregorian dates. MORLEY's statement concerning the Hindu invention of the decimal notation is incorrect (p. 177). That invention must have been made long before the VIIIth century, for it was already known to the Syriac writer SEVERUS SÊBÔKHT, who flourished about the middle of the VIIth century (see my *Introduction* 1, 493) (2).

GEORGE SARTON.

Samuel Eliot Morison.—*The founding of Harvard College* (xxvi+472 p. with abundant illustrations and maps). Cambridge, Harvard University Press, 1935 ($5).

Harvard College in the seventeenth century (2 vols. xxii+708 p., with abundant illustrations). Cambridge, Harvard University Press, 1936 ($7.50).

The development of Harvard University, 1869-1929 (xc+660 p., with abundant illustrations). Cambridge, Harvard University Press, 1930 ($6).

The Tercentenary of Harvard University will be celebrated with due pomp this September (1936). Such celebrations will be especially grateful to the many thousands of Harvard men all over the world, but they should not (and will not) leave the rest of the people indifferent. It is worth recording that this great institution will soon begin the fourth

(2) See also B. DATTA and A. N. SINGH : *History of Hindu mathematics* (vol. 1, 281 p., Lahore, 1935), together with S. GANDZ's elaborate review (*Isis*, 25, 478).

century of its existence. To be sure some European universities are older, yet the majority of them are younger, much younger. The Tercentenary celebrations have been in the course of preparation for many years. The fundamental requirement was a complete history of the University, a gigantic task for which no one was better equipped than the Harvard historian S. E. MORISON (Harvard class of 1908). MORISON is a Bostonian who, in addition to his knowledge of American history, has a life-long and deep familiarity with New England archaeology and genealogy. He is also very well acquainted with the English background, for he spent three years in Oxford as a teacher of American history and interpreter of American institutions (1922-5).

Thus far four volumes of his History of Harvard have been published, dealing with the seventeenth century and with the last half century (1869-1929). This final volume was the first to be published (1930) and we shall briefly dispose of it. MORISON was not the author of it but simply the editor. It consists of a series of 38 chapters, each of which deals with the recent history of one of the Harvard departments. Each chapter has been contributed by one of the most distinguished members of the department concerned. We are thus given a series of historical sketches, all of which are very interesting, though they are, as we would expect, very unequal. This book will be very precious to the Harvard graduates for they will find in it the history of events which they have witnessed themselves, anecdotes concerning their old friend and schoolmates, portraits of beloved professors, etc. The only serious gap in that account is the absence of a history of the Sanskrit and Indic department. Prof. LANMAN's illness is a very bad excuse, for that chapter should have been written by someone else anyhow, whose main duty would have been to describe the almost incredible achievements of a man who has done as much for Harvard as any other scholar and to whom Harvard has been singularly ungrateful. CHARLES ROCKWELL LANMAN is known among orientalists all over the world, and many of them, especially among our Asiatic friends, know Harvard only because of LANMAN. The *Harvard Oriental Series*, which he edited, is one of the greatest titles of Harvard to be considered not simply as a school or college, but as a center of learning.

To return to the history proper, that is, to the three magnificent volumes devoted to the seventeenth century. I have already spoken of the first one (*Isis* 24, 485). Let me add that such a book should be of value to scholars who are studying the history of mediaeval universities, for the circumstances of Harvard birth were comparable in many respects to those of her predecessors, and they are far better known. Harvard

foreign origins (Cambridge, Oxford, Dublin, Scotch, Dutch, Italian and Spanish) are explained in a masterful manner.

The simplicity and humbleness of the beginnings can hardly be exaggerated. It is very touching to hear of the sturdy farmers of New England who gave their strings of wampum, pine-tree shillings and quarter-bushels of wheat " to advance *Learning* and perpetuate it to Posterity," also to realize that the most important gift to the college down to the year 1650 was made in that year by Puritan exiles in the Bahaman island of Eleuthera (*Isis* 15, 420).

Presumably our readers will take special interest in the chapters (VII to XIII) discussing the early methods of teaching and the early curricula. MORISON discusses these in the following order : grammar, rhetoric and logic; Greek and Hebrew; mathematics and astronomy; physics; metaphysics and moral philosophy; history, theology and medicine. Each of these disciplines was the occasion of lively controversies, the echoes of which were plainly heard in the New World. For example, RAMUS *vs.* ARISTOTLE, the existence or non-existence of a vacuum, the new astronomy. With regard to the latter

> " It is abundantly clear " concludes the author (p. 222) " that the Copernican system was officially sanctioned and taught at Harvard at least as early as 1659; that the college tutors were alert to learn of new discoveries in Astronomy, and prompt to ' season and possesse the youth of New England ' with the ' reall Experimental way of acquiring knowledge '; that the College possessed a telescope as early as 1672, with which observations useful to Sir ISAAC NEWTON were made; and that this group of young Harvard scholars, BRIGDEN, CHEEVER, NOWELL, the MATHERS, and above all THOMAS BRATTLE, were in their small and humble way worthy predecessors of the BONDS and the PICKERINGS and HARLOW SHAPLEY."

The study of Hebrew " linguarum mater " was given considerable importance, even more so than in Oxford and Cambridge. The Harvard dons were acquainted not only with the Hebrew Bible, but with the Targums and Talmuds and with rabbinical literature. Judging from the catalogue of the library published in 1723, it included a rich collection of rabbinical books (see p. 289), In 1681 and following years there was much discussion on the query whether the Hebrew vowel-points are of divine origin as well as the letters themselves (1). The " beginning Hebrew " book at Harvard was the Horologium ebraeum (fig. 1) of the mathematician WILHELM SCHICKARD (1592-1635), professor in Tübingen, but various other works were used for advanced study (see p. 203). Aramaic was regularly taught, and Arabic, not unknown (p. 321).

(1) In 1687 GURDON SALTONSTALL (A.B. 1684, later governor of the colony), defended the affirmative on the question " an puncta hebraea sint divinae originis " (p. 616).

Chapter XIV dealing with the College library (1655-1723) leaves one a pleasant impression. The catalogue of 1723 already mentioned (fig. 2) records some 3516 volumes which are fairly representative of seventeenth century thought (" lots of theology and a little of everything else ").

WILHELMI SCHICKARDI

HOROLOGIUM

EBRÆUM,

Sive

CONSILIUM,

Quomodo Sancta Lingua ſpacio

XXIV. Horarum, ab aliquot Collegis

ſufficienter apprehendi queat;

EDITIO ULTIMA

Prioribus omnibus accuratior, plenior & ad

uſum tyronum accommodatior, quod Præfatio ad

Lectorem docebit.

Experire, non ride.

ULTRAJECTI.

Apud JOHANNEM à SAMBIX,

clɔ Iɔc LXI.

FIG. 1. — WILHELM SCHICKARD's " Hebrew in XXIV hours." First printed in Tübingen, 1614. Various English and Dutch editions of it were used by Harvard students. The one reproduced (Utrecht, 1661) bears the autograph of INCREASE MATHER *(Courtesy of Harvard Press)*.

The history of the early Harvard Press is intimately connected with that of the Indian college (1655-98) of which it was a part and which it did not survive. Its greatest achievement was the printing of JOHN ELIOT's Algonquian translation of the whole Bible in 1663 (fig. 3): this was the first Bible printed in the New World or in the British Empire (outside of Europe). It was at one and the same time an astounding

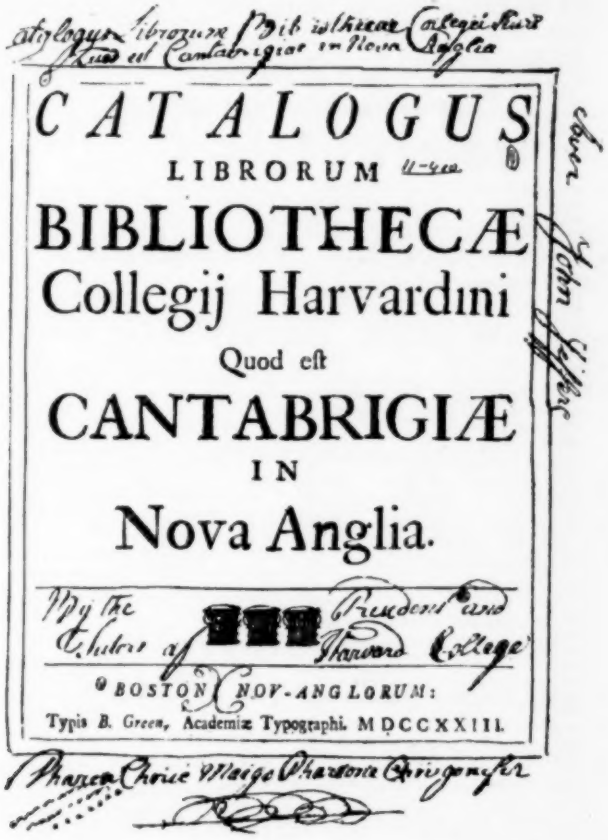

CATALOGUS
LIBRORUM
BIBLIOTHECÆ
Collegij Harvardini
Quod eſt
CANTABRIGIÆ
IN
Nova Anglia.
BOSTON NOV-ANGLORUM:
Typis B. Green, Academiæ Typographi. MDCCXXIII.

FIG. 2. — Catalogue of the Harvard Library in 1723. First public library catalogue printed in America *(Courtesy of Harvard Library)*.

feat of scholarship (the greatest in that century in America) and of typography, indeed a colossal task for a little handpress and a small font of type (1200 p. in Algonquian). It was reprinted in 1685.

President DUNSTER's ambition to make of Harvard the Indian Oxford as well as the New English Cambridge was frustrated. The Indian

College was a conspicuous if honorable failure, with the exception of the Press which issued in eighteen years (1655-72) about one hundred books and pamphlets, of which 15 were in the Indian language and 85 in English. The most famous of these books was the Algonquian Bible, the most popular MICHAEL WIGGLESWORTH's *Day of doom* (1662), the

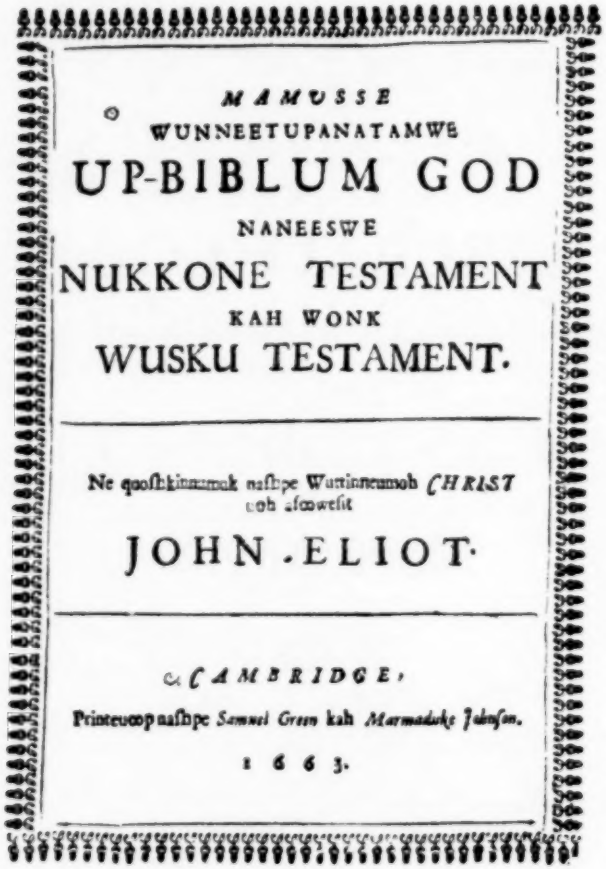
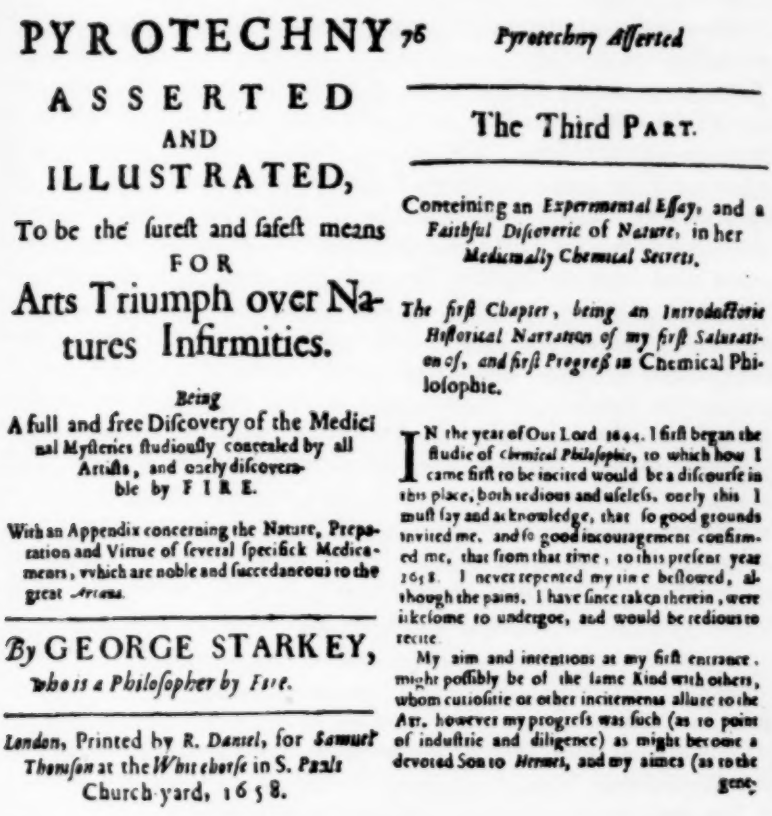

MAMUSSE
WUNNEETUPANATAMWE
UP-BIBLUM GOD
NANEESWE
NUKKONE TESTAMENT
KAH WONK
WUSKU TESTAMENT.
Ne quoshkinnumuk nashpe Wuttinneumoh CHRIST
noh asoowesit
JOHN. ELIOT.
CAMBRIDGE,
Printeuoop nashpe Samuel Green kah Marmaduke Johnson.
1 6 6 3.

FIG. 3. — Complete translation of the Bible into Algonquian by JOHN ELIOT, printed by the Indian Press of Harvard College in 1663 *(Courtesy of Harvard Library)*.

best seller of its time. A translation of the *Imitatio Christi* was already in press in 1669 when it was forbidden by the General Court because of its Popishness. The most famous Indian alumnus was CALEB CHEESHAHTEAUMAUK, who wrote in 1663 a Latin address to the benefactors

of the College (text p. 355, facsimile p. 345) which was duly transmitted to the Hon. ROBERT BOYLE, governor of the New England Company.

This history might have easily degenerated into a lifeless archaeological record, but Professor MORISON reveals himself a true master in the evocation of his main personages—the picturesque presidents and dons of the struggling college, the colonial governors and officers, or such extraordinary characters as INCREASE MATHER (A.B. 1656), his son COTTON



PYROTECHNY 76 *Pyrotechny Asserted*

ASSERTED
AND
ILLUSTRATED,

To be the ſureſt and ſafeſt means
FOR
Arts Triumph over Natures Infirmities.

Being
A full and free Diſcovery of the Medicinal Myſteries ſtudiouſly concealed by all Artiſts, and onely diſcoverable by FIRE.

With an Appendix concerning the Nature, Preparation and Virtue of ſeveral ſpecifick Medicaments, which are noble and ſuccedaneous to the great *Arcana*.

By GEORGE STARKEY,
Who is a Philoſopher by Fire.

London, Printed by R. *Daniel*, for *Samuel Thomſon* at the *White horſe* in S. *Pauls* Church-yard, 1658.

The Third PART.

Conteining an *Experimental Eſſay*, and a *Faithful Diſcoverie* of *Nature*, in her *Medicinally Chemical Secrets*.

The firſt Chapter, being an Introductorie Hiſtorical Narration of my firſt Salutation of, and firſt Progreſs in Chemical Philoſophie.

IN the year of Our Lord 1644. I firſt began the ſtudie of *chemical Philoſophie*, to which how I came firſt to be incited would be a diſcourſe in this place, both tedious and uſeleſs, onely this I muſt ſay and acknowledge, that ſo good grounds invited me, and ſo good incouragement confirmed me, that from that time, to this preſent year 1658. I never repented my time beſtowed, although the paines, I have ſince taken therein, were likeſome to undergoe, and would be tedious to recite.

My aim and intentions at my firſt entrance, might poſſibly be of the ſame Kind with others, whom curioſitie or other incitements allure to the Art, however my progreſs was ſuch (as to point of induſtrie and diligence) as might become a devoted Son to *Hermes*, and my aimes (as to the gene-

FIG. 4. — A treatise by the Bermudian GEORGE STIRK or STARKEY (A.B. 1646; d. 1665), the first Harvard chemist *(Courtesy of Harvard Press)*.

MATHER (A.B. 1678) and other members of the same powerful tribe, or early scientists such as the chemist GEORGE STIRK or STARKEY (A.B. 1646), for whom see *Isis* 9, 442; 11, 333 (fig. 4), the astronomer THOMAS BRATTLE, (A.B. 1676), the Algonquian apostle JOHN ELIOT (1604-90). Not the least moving of all these portraits is the one of

" the typical Harvard man of 1700 " (p. 562-5), which in a way gives us the pith of the whole work.

Much space is naturally devoted to the many intellectual crises which shook the colony and jeopardized the precarious existence of state, church and college, for example the controversies over infant baptism (p. 305 ff.) and over witchcraft (p. 494 ff.). For the last named subject the author could of course avail himself of the fundamental investigations of GEORGE LYMAN KITTREDGE (1929; *Isis* 13, 138-41). Of necessity considerable space is devoted also to what we would call " college politics," and though much of that is now of little interest except to antiquarians, it helps us to realize the intricacies of human loyalties. We learn once more that loyalties are often stronger in proportion to the smallness or meanness of their objects. The progress of civilization might be described in terms of loyalties of increasing scope; it is exceedingly slow and precarious at best. Looking at this from another angle, the most interesting stories for most people are those which are the most personal or the most local in character, the most concrete. This explains why a " history of science society " can hardly hope yet to be as successful as a local antiquarian or genealogical society. MORISON's book is such that it will be equally precious to the Harvard or New England antiquarian, and to the historian of culture. No student of seventeenth century thought can afford to neglect it; this applies primarily of course to the American student, but the European student will find it worth while to use it too. Apart from lists and other technical pages which may be skipped, the book is beautifully and pleasantly written, racy, salty, pithy, and admirably illustrated. Indeed it will increase the prestige of the Harvard University Press, which is a worthy descendant of the Indian press of the second half of the seventeenth century.

GEORGE SARTON.

Johanne Christiansen.—*Gyldne Laegeraad saerlight om Diaet.* 38 Tegninger af J. DORPH, Gyldendalske Boghandel, Nordisk-Forlag, Copenhagen 1933 (11.50 kr.).

The author of this study " Golden maxims on diet "—dedicated to BENITO MUSSOLINI and published with his approval!—is a Danish woman physician, the daughter of a professor of Physics at the University of Copenhagen. While at the Danish University medical school, she was advised by the professor of surgery, OSCAR BLOCH, to study the works of HIPPOCRATES in order to elucidate some historic point; but she then had little time for research. After she went to Italy to live she obtained a copy of the old Salernitan poem, *The Regimen Sanitatis*, on health and longevity, and during her leisure she was able to compare

the hygienic *Aphorisms* of HIPPOCRATES and the *Regimen of Salerno* and certain excerpts from the Icelandic *Elder Edda* with the modern theories of calories and vitamins. She quotes many authors from PYTHAGORAS to MUSSOLINI to illustrate the similarity of diets from the early days to the present.

In her translations from HIPPOCRATES and the *Regimen* and other sources she has tried to compare the texts. For example, she quotes from HIPPOCRATES, " Healthy men shall eat much and drink little in winter ; their wine should not be too diluted nor vegetables too liberally eaten, nor any food made so appetizing that it tempts beyond sufficiency." The Salerno poem says, " The appetite should govern the choice of food but not the amount eaten." Food should be eaten with pleasure, preferably " sitting at a table with the beloved wife and happy children," adding " one should drink water only before a meal and not during meals." Hippocrates gives advice as to the cooking of food and the value of a slimming diet : " Bread should be made of coarse meal and well baked." GALEN approves of this, and the Salerno poem enlarges upon it. MUSSOLINI agrees with these ideas, but also urges an increased consumption of wine in the drinking water. HIPPOCRATES withholds foods from feverish patients, particularly milk, but feeds them liberally during convalescence. The Salernitan poem emphasizes this teaching. HIPPOCRATES says that fat men should fast often, walk rapidly after eating, lie on a hard bed, go lightly clad, for the fat are in more danger of death than the lean. To this GALEN adds, " A fat belly provides no clever thoughts." The Salerno poem says, " Beware of the food you like the best." The Edda continues, " Sluggards eat without thought of future discomfort. They die for their stomach's sake," to which MUSSOLINI also adds, " Easy-chair and slippers are man's doom."

Dr. CHRISTIANSEN also quotes comparative sayings about diet in disease, including diabetes, dropsy, asthma, hay fever, and jaundice, as well as diseases of the sex organs and of nursing mothers and their infants. In fact the 256 pages are filled with such quotations, thus making a valuable addition to the studies in medical history. The line drawings are interesting, and there is an envelope in the cover of the book containing two hundred receipts for scientific modern dietaries.

KATE C. MEAD, M.D.

Forty-sixth Critical Bibliography

of the

History and Philosophy of Science and of the History of Civilization

(to end of February 1936,—with special reference to China and Japan)

This forty-sixth Bibliography contains about 525 items of which 105 deal with China and Japan. They have been kindly contributed by the seven following scholars belonging to 3 different countries.

C. W. ADAMS (Hertford, England)
C. A. KOFOID (Berkeley, Cal.)
C. D. LEAKE (San Francisco)
R. K. MERTON (Cambridge, Mass.)
J. PELSENEER (Brussels)
A. POGO (Washington, D.C.)
G. SARTON (Cambridge, Mass.).

This Bibliography includes as usual a series of addenda and errata to SARTON's *Introduction to the History of Science*, vols. 1 and 2 (Baltimore and London, 1927 and 1931). Its purpose and methods have been explained in the preface to the thirty-eighth Critical Bibliography (*Isis* 20, 506-08).

The sections on China and Japan are especially full, as I have liquidated as much as I could of my stock of notes concerning them.

I have in my drawers a large number of notes which I will be glad to publish as soon as I have been able to check them upon the originals.

I entreat the authors of relevant books and papers to send me copies of them *as promptly as possible* in order that their studies may be registered in this bibliography and eventually reviewed and discussed. By so doing they will not simply help me and every other historian of science but they will help themselves in the best manner, for they will obtain for their work the most valuable publicity and its certain incorporation into the literature of the subject.

Many of the notes were checked and the final manuscript and proofs of this Critical Bibliography were kindly read by Dr. M. C. WELBORN.

Harvard Library 185.
Cambridge, Mass.

GEORGE SARTON.
3602.05.

PART I

FUNDAMENTAL CLASSIFICATION (CENTURIAL)

Vth Century B.C.

Edelstein, Ludwig. HIPPOKRATES von Kos. PAULY-WISSOWAS *Realenzyklopädie der klassischen Altertumswissenschaft*, 1290-1343 (no date, received Jan. 1936). ISIS

Very elaborate addenda to the article published in vol. 8 of same work. G. S.

Hippokrates. Die Werke des HIPPOKRATES. Die hippokratische Schriftensammlung in neuer deutscher Uebersetzung, hrsg. von RICHARD KAPFERER unter Mitwirkung von GEORG STICKER u. a. III : Die Diät (Lebensordnung; 1. und 2. Buch). Uebersetzt von R. KAPFERER. 96 p. IV : Die Diät (Lebensordnung ; 3. Buch). Die Träume (Lebensordnung ; 4. Buch). Die gesunde Lebensordnung. Uebersetzt von R. KAPFERER. 80 p. VI : Luft, Wasser und Ortslage. Uebersetzt von R. KAPFERER. 84 p. IX : Die Diät (Lebensordnung) in akuten Krankheiten. 1. und 2. Buch. Uebersetzt von R. KAPFERER. 96 p. Stuttgart, Hippokrates-Verlag, 1934-35. ISIS

Reviewed by ALDO MIELI, *Archeion* 17, 323-24, 1935.

IVth Century B.C. (whole and first half)

Wilhelm, Hans-Eberhard. Turnlehrer und Arzt in PLATONS *Gorgias*. *Klinische Wochenschrift* 14, 4 p., 1935. ISIS

Wundt, Max. PLATONS *Parmenides*. 81 p. (Tübinger Beiträge zur Altertumswissenschaft, 25). Stuttgart, KOHLHAMMER, 1935. ISIS

Ueta, Joe. SHIH SHEN's catalogue of stars, the oldest star catalogue in the Orient. *Publications of the Kwasan Observatory* 1, 48 p., Kyoto, 1930. ISIS

This important paper has already been mentioned in *Isis* (17, 561; see also 15, 201) but not in the chronological section and hence students of ancient science may have overlooked it. The author has made an elaborate study of the catalogue of stars contained in the *K'ai yüan chan ching* and established the fact that those stars were observed in or about 360 B.C.,

and that some of the observations were revised later. The paper is very technical and may require further analysis, but it is well to remember that Dr. UETA has given us a Chinese catalogue of stars (some 742 stars) which is two centuries anterior to HIPPARCHOS. G. S.

IVth Century B.C. (second half)

Drabkin, Israel E. ARISTOTLE, *De caelo* 2.6, 288*a*, 22. *Classical weekly* 29, 93-6, 1936. ISIS

Discussing ARISTOTLE's views on motion. G. S.

Senn, Gustav. THÉOPHRASTE et l'ancienne biologie grecque. *Archeion* 17, 117-32, 1935. ISIS

IIIrd Century B.C. (whole and first half)

Kapp, A. G. Arabische Übersetzer und Kommentatoren EUKLIDS, sowie deren math.-naturwiss. Werke auf Grund des Ta'rīkh al-Ḥukamā' des IBN AL-QIFṬĪ. *Isis* 24, 37-79, 1935. ISIS

IIIrd Century B.C. (second half)

Tropfke, J. Die Siebeneckabhandlung des ARCHIMEDES. *Osiris* 1, 636-51, 11 fig., 1936. ISIS

Analysis of the Archimedian work preserved in the Arabic translation of THĀBIT IBN QURRAH and edited by the late C. SCHOY in 1927 (*Isis* 10, 495-7). G. S.

IInd Century B.C. (whole and first half)

Dubs, Homer H. Eclipses during the first fifty years of the earlier HAN Dynasty. *Journal of the North China branch of the Royal Asiatic society* 66, 73-82, 1935. ISIS

"During the first fifty years of the HAN Dynasty, from the beginning of HAN KAO-TSU's reign in 206 B.C. to the end of the Emperor HSIAO-WEN's reign in 156 B.C. the *History of the earlier Han Dynasty* and the *Historical record* by SSŪ-MA CH'IEN record twelve eclipses of the sun. The *Historical record* adds one more. Of these, only six in their present form check with modern astronomical calculations. In this paper it is proposed to examine each of these twelve eclipses and endeavour to determine just when each occurred." "In five out of six eclipses that in their present form do not check with astronomical calculations, we found that a simple emendation would provide a usable date."

Ist Century (second half)

Klebs, Arnold C. Incunable editions of Pliny's *Historia naturalis*. *Isis* 24, 120-21, 1935. ISIS

IInd Century (whole and first half)

Chabanier, Eugène. La géographie mathématique dans les manuscrits de Ptolémée. *Bulletin de la section de géographie* 22 p., 1934. ISIS

Haberling, Wilhelm. Der Hygieniker und Sportarzt Antyllos. *Klin. Wschr.* 14, 1615-19, 1935. ISIS

Walter, Georg. Zu Pseudo-Soranus *Quaestiones* (Ein griechisch-lateinisches Glossar in Versform. Codex Leninopolitanus Lat. F. v. VI. 3, fol. 39 r°). *Sudhoffs Archiv für Geschichte der Medizin* 28, 267-78, 1935. ISIS

IIIrd Century (whole and first half)

Miyazaki, Ichisada. Two problems in regard to the Sui ching chu. *Shigaku Zasahi* 45, 861-72, 1934 (in Japanese). ISIS

Abstracted by Edwin C. Reischauer, Abstracts of articles appearing in current Japanese periodicals, pp. 18-19, American Council of Learned Societies, 1935.

IVth Century (whole and first half)

Kitayama, Junyu. Metaphysik des Buddhismus. Versuch einer philosophischen Interpretation der Lehre Vasubandhus und seiner Schule. xv+268 p. (Veröffent. des Oriental. Seminars der Univers. Tübingen. Abhandl. zur Oriental. Philologie u. zur allgemeinen Religionsgesch., 7). Stuttgart, Kohlhammer, 1934. ISIS

Reviewed by Walter Liebenthal, OLZ 39, 48-50, 1936; by C. A. F. Rhys Davids, *Journal of the Royal Asiatic Society* 143, 1936.

Wu, Lu-Ch'iang. An ancient Chinese alchemical classic, Ko Hung on the gold medicine and on the yellow and the white. The fourth and sixteenth chapters of *Pao-p'u-tzŭ*. Translated from the Chinese. With an introduction, etc., by Tenney L. Davis. *Proceedings of the American Academy of Arts and Sciences* 70, 221-84, 8 fig., 1935. ISIS

"*Pao-p'u-tzŭ*, of which two of the most interesting chapters are now made available for the first time in a European language, is probably the widest known and highest regarded of the ancient Chinese treatises on alchemy. It has been preserved for us as part of the Taoist canon. It shows us the art matured by five or six centuries of practice, having its traditional heroes and an extensive literature, its technique and philosophy now clearly fixed, its objectives and pretentions established. This art the author examines in a hard-headed manner and expounds in language which is remarkably free from subterfuge. KO HUNG (about 281-361 A.D.)—see SARTON's *Introduction* (vol. 1, 355)—was one of the outstanding scholars of the Chin dynasty, a Taoist philosopher and writer on medical, alchemical, literary, and historical subjects. He defended the Taoist doctrines at a time when they had not yet gained wide currency, and propagated them before Taoism had assumed a churchly organization. He believed in magic but probably no more so than his contemporaries. He was credulous but had the admirable credulity of an inquiring experimentalist who was well aware of the powers and possibilities of nature."

This continuation to DAVIS' paper published in *Isis* 18, 210-30, 1932, is of great importance. Translations of Chinese scientific texts are badly needed and this one is particularly welcome. To the translation provided by a Chinese scholar, DAVIS has added a well illustrated introduction, an abstract, and an index of Chinese words. G. S.

IVth Century (second half)

Blake, Robert Pierpont; De Vis, Henri. EPIPHANIUS De Gemmis. The old Georgian version and the fragments of the Armenian version by R. P. BLAKE and the Coptic-Sahidic fragments by H. DE VIS. CXXIII+335+51 p. (Studies and documents edited by KIRSOPP LAKE and SILVA LAKE, 2). London, CHRISTOPHERS, 1934. ISIS

Reviewed by GEORGE SARTON, *Isis* 24, 127-29, 1935.

Thompson, D'Arcy Wentworth. Zum *Liber medicinae ex animalibus* des SEXTUS PLACITUS. *Mitt. Z. Gesch. d. Med.* 35, 150, 1936. ISIS

VIth Century (second half)

Krusch, Bruno. Kulturbilder aus dem Frankenreiche zur Zeit GREGORS VON TOURS (d. 594). Ein Beitrag zur Geschichte des Aberglaubens. *Sitzungsberichte der preussischen Akademie der Wissenschaften, phil.-hist. Klasse.* 26, 785-800, Berlin, 1934. ISIS

VIIth Century (second half)

Mingana, Alphonse. Medico-mystical work by SIMON OF ṬAIBŪTHEH (d.c. 680). Syriac text with English translation and notes (Wood-

brooke studies, Christian documents in Syriac, Arabic, and Garshūni, edited and translated with a critical apparatus. Vol. VII, *Early Christian mystics*, p. 1-69, 280-320). Cambridge, HEFFER, 1934.

ISIS

Reviewed by GEORGE SARTON, *Isis* 24, 129-32, facs., 1935.

VIIIth Century (second half)

Baudoux, Claire. A propos de la lettre du patriarche TIMOTHÉE au prêtre et docteur PÉTHION. *Annuaire de l'Institut de philologie et d'histoire orientales* 3, 37-40, Bruxelles, 1935. ISIS

" Le savant orientaliste français, HENRI POGNON, a publié et traduit en 1903 une intéressante lettre du patriarche nestorien TIMOTHÉE (728-823) au prêtre et docteur PÉTHION. Cette lettre jette une vive lumière sur les traductions arabes des écrits grecs profanes. Elle nous apprend, en effet, que les traductions arabes faites d'après une version syriaque étaient seules estimées; et que celles qui provenaient directement de l'original grec étaient considérées comme barbares. Le khalife alors régnant, qui était soit EL MAHDI (775-785), soit EL-HADI (785-786), soit le célèbre HAROUN-ARRACHID (786-809), méprisait à ce point les traductions directes qu'il ne daignait même pas les regarder."

IXth Century (whole and first half)

Gandz, Solomon. The sources of AL-KHOWĀRIZMĪ's *Algebra*. *Osiris* 1, 263-77, 1936. ISIS

Contents: I. Introduction, 1. AL-KHOWĀRIZMĪ and his algebra; II. The geometry and EUCLID, 2. EUCLID or the *Mishnat ha middot*, 3. The order of the letters; III. The algebra and DIOPHANTUS, 4. The Arabic translation of DIOPHANTUS, 5. The contents, 6. Primitive and advanced algebra, 7. The terminology; IV. The Babylonian element, 8. The term algebra, 9. The term for the diagonal, 10. The reciprocal and the algebra of inheritance.

Smith, Margaret. The forerunner of AL-GHAZĀLĪ. *Journal of the Royal Asiatic Society* 65-78, 1936. ISIS

... " These examples, to which others might be added, show clearly AL-GHAZÂLÎ's indebtedness to his great predecessor, both for the main trend of his ascetical, devotional, and mystical teaching and for many of the ideas and illustrations of which he makes use in his rule for the religious life. Living two and a half centuries later than AL-MUḤÂSIBÎ (d. 857), AL-GHAZÂLÎ had access to a much greater store of material, and the wide extent of his travels for which we find no parallel in the life of AL-MUḤÂSIBÎ, together with his own outstanding genius, enabled him to develop and expand the lines of thought suggested in the writings of his predecessor, but there is no doubt that the foundations of that great system of orthodox Islamic Mysticism which AL-GHAZÂLÎ made it his business to bring to completion, had already been well and truly laid."

IXth Century (second half)

(Rāzī). Bur' al-sā'ah li shaikh al-aṭibba' al-imām al-failusūf ABĪ BAKR MUḤAMMAD IBN ZAKARYA AL-RĀZĪ... Nasharahā 'IZZAT AL-'AṬṬĀR. 16 p. Al-maktabat al-tijāriyyat al-kubrā. Cairo, 1354 = 1936 (in Arabic). ISIS

The editor of this text, secretary of the Union of Syrian young people in Cairo, tells us (p. 5) that he prepared his edition on the basis of five MSS, one in his possession and four others in the Egyptian national library, and of an edition "printed in Paris" containing many annotations by one Doctor KĪK (?), professor of pharmacy in the French medical school (I am unable to identify that French edition and its author). However the *Bur'al-sā'ah* was actually published in Lucknow 1890 (24 p. lithogr.) together with the *Maqālah fī-l-faṣd* of IBN AL-TILMĪDH (XII-1) and the *Daqā'iq al-ḥikmah* ascribed to ARISTOTLE. This edition is thus at least the third. The *Bur'al-sā'ah* is a very short treatise on instantaneous cures of various ailments and pains. See BROCKELMANN, vol. 1, p. 234, n° 9, where nine more MSS are mentioned. G. S.

Xth Century (whole and first half)

Borissov, A. Sur le nom "Tankalouchā." *Journal asiatique* 226, 300-05, 1935 (received Feb. 1936). ISIS

Apropos of the *Kitâb Tankalûsha* of IBN WAḤSHĪYA. (*Introd.* vol. 1, 634). TANKALÛSHA was identified by BOLL (*Sphaera* 1903) with TEUCROS of Babylon, an astrologer of the beginning of our era. G. S.

Farmer, Henry George. AL-FĀRĀBĪ's Arabic-Latin writings on music. In the *Iḥṣā al-'ulūm* (Escorial library, Madrid, no. 646), *De scientiis* (British Museum, Cott. MS. Vesp. B. X., and Bibl. Nat., Paris no. 9335), and *De ortu scientiarum* (Bibl. Nat., Paris, no. 6298, and Bodleian library, Oxford, no. 3623), etc. The texts edited, with translations and commentaries. Quarto, 65 p., facs. Glasgow, Civic Press, 1934. ISIS

Reviewed by GEORGE SARTON, *Isis* 24, 132-34, 1935.

Wolfson, Harry Austryn. ISAAC ISRAELI on the internal senses. *Jewish studies in memory of George A. Kohut*, 583-98, 1935. ISIS

"In his discussion of the soul in *Liber de elementis* ISAAC ISRAELI incidentally refers to the distinction between the five senses and the postsensationary faculties, which throughout medieval philosophy, Arabic, Hebrew, and Latin, are known by the contrasting terms external senses and internal senses. Like his successors the Ikhwân al-Ṣafâ he designates them by

the terms 'corporeal' and 'spiritual' senses, and like his predecessors Ḥunain ibn Iṣḥâḳ and Razi he divides the spiritual or internal senses into three: (1) imagination, (2) cogitation, (3) memory."

Xth Century (second half)

Arberry, Arthur John. The Mawāqif and Mukhāṭabāt of Muḥammad ibn 'Abdi-l-Jabbār al-Niffarī, with other fragments edited for the first time, with translation, commentary, and indices. xvii+276+218 p.) (Gibb memorial series, new series 9). London, Luzac, 1935. ISIS

Reviewed by R. Paret, OLZ 39, 32-33, 1936; by E. L., *Al-Andalus* 3, 465, 1935.

Funkhouser, H. Gray. A note on a tenth century graph. *Osiris* 1, 260-62, 1926. ISIS

"The graph given here in facsimile is of significance in the history of graphic methods in that it appears to be the oldest extant example of an attempt to represent changeable values graphically which in appearance closely resembles modern practice. The distinguishing feature is the use of a grid as a background for the drawing of the curves. The graph dates from the tenth, possibly eleventh century, and forms a part of a manuscript discovered by Sigmund Günther in 1877."

XIth Century (whole and first half)

Leroy, Maurice. Grégoire Magistros et les traductions arméniennes d'auteurs grecs. *Annuaire de l'Institut de philologie et d'histoire orientales* 3, 263-94, Bruxelles, 1935. ISIS

Nazim, M. A unique manuscript on astronomy. *Annual report of the archaeological survey of India*, 1929-30, 232-33, Delhi, 1935. ISIS

Sir Richard Burn of Oxford has kindly drawn my attention to this account of a unique Birunian ms. found by Dr. Nazim in an obscure library of Aḥmadabad. "It is a translation into Arabic of a lost Sanskrit work on astronomy named *Karaṇatilaka* written by Vijayânanda, son of Jayânanda of Benares. Al-Bîrûnî made this translation at the request of some friends who were interested in the study of astronomy. As the name *Ghurratu's-zîjat* is mentioned in *Indica* (II, 90), it is evident that this translation must have been prepared some time before al-Bîrûnî had completed his great work on India. Nothing is known about Vijayânanda and his work *Karaṇatilaka* except what is given by al-Bîrûnî in his brief introduction to the *Ghurratu'z-zîjat*. He says that *Karaṇatilaka* was composed in the year 888 of the Śaka era (A. D. 966), that Vijayânanda, 'the commentator' was a scholar of great reputation, and that *Karaṇatilaka* was looked upon

as a standard work on astronomy in India. AL-BĪRŪNĪ held a high opinion of this book. He calls it ' the first of the canons,' and reckons an era called ' the era of the canon *Karaṇatilaka* ' from the date of its composition. He has made numerous references to *Karaṇatilaka*, and has given long quotations from it on the method of calculating the dominant of the hour; on the *ahargaṇa* rule; the method of computing the diameter of the sun; the degree of the distance of a star which is necessary for its helical rising; and the method of calculating the two unlucky *yogas* called *Vyatipâta* and *Vaidhṛita*. The manuscript is not complete and a few leaves are wanting towards the end. It comprises 34 double folios of small and carelessly written Naskh." G. S.

XIth Century (second half)

Menéndez Pidal, Ramón. The Cid and his Spain, translated by HAROLD SUNDERLAND. XII+470 p. London, MURRAY, 1934. ISIS

Reviewed by HARRIET LATTIN, *Speculum* 11, 147-48, 1936.

Zinner, Ernst. Die Tafeln von Toledo (Tabulae Toletanae). *Osiris* 1, 747-73, 1935. ISIS

" Der Grundstock der Toledischen Tafeln wurde im 11. Jahrhundert durch arabische Gelehrte in Toledo unter Benützung der Tafeln des AL-KHWĀRIZMĪ und des AL-BATTĀNĪ geschaffen. Diese Tafeln wurden in der 1. Hälfte des 12. Jahrhunderts zur Herstellung christlicher Tafeln für Toledo und andere Orte verwendet. Auch entstanden Erklärungen, die vielleicht auf AL-ZARKĀLĪ zurückgehen, und später von GERARD VON CREMONA benützt wurden, als er die Tafeln durch seine Tafeln für Cremona vermehrte und die Erklärungen ordnete und wohl durch eigene Abschnitte vermehrte. Am Ende des 13. Jahrhunderts setzte die Kritik an den Tafeln und ihren Abzweigungen ein, woraufhin in Paris die Alfonsischen Tafeln entstanden."

XIIth Century (whole and first half)

Grabmann, Martin. Handschriftliche Forschungen und Mitteilungen zum Schrifttum des WILHELM VON CONCHES und zu Bearbeitungen seiner naturwissenschaftlichen Werke. 57 p. *Sitzungsberichte der Bayerischen Akademie der Wissenschaften* H. 10, 1935. ISIS

Remarks concerning WILLIAM's scientific writings: 1. *Philosophia mundi*; 2. *Dragmaticon philosophiae*; 3. Eine dritte *Philosophia* seu *Summa Philosophiae* des WILHELM VON CONCHES; 4. *Moralium dogma philosophorum*—kein echtes Werk; 5. Kommentar zum *Timaeus* des PLATO; 6. Der Kommentar zur *Consolatio philosophiae* des BOETHIUS; 7. Kommentare zu PRISCIANUS, MACROBIUS und MARTIANUS CAPELLA. Followed by remarks concerning adaptations of these writings: 1. RADULFUS DE LONGO CAMPO, Kommentar zum *Anticlaudianus* des ALANUS DE INSULIS (1215). *Summa Radulfi (Cornicula)*; 2. Der *Liber philosophie Boetii* des BARTHOLOMAEUS VON PARMA (XIII-2); 3. Die *Cosmographia* im Clm. 331. G. S.

Lippmann, Edmund O. v. Die vier Elemente in den " Quaestiones naturales " des ADELHARD VON BATH. *Die Naturwissenschaften* 23, 749-51, 1935.

Millás y Vallicrosa, J. Una obra astronomica desconocida de JOHANNES AVENDAUT HISPANUS. *Osiris* 1, 451-75, 1936. ISIS

Apropos of JOHN OF SEVILLE (*Intr.* 2, 169-72) and critical edition of an unknown astronomical text of his " incipiunt sententie de diuersis libris excerpte in quibus exponuntur dubitationes multe que fiunt in regulis equacionum planetarum et in ascensionibus signorum et in ceteris que in tabulis continentur." after two MSS Madrid; St. John's, Oxford. G. S.

Nemoy, Leon. Contributions to the textual criticism of JUDAH HA-LEVI's *Kitāb al-Khazarī*. *Jewish quarterly review* 26, 221-26, 1936. ISIS

Sarton, George. " Standing on the shoulders of giants." *Query* no. 53. *Isis* 24, 107-09, 1935. ISIS

XIIth Century (second half)

Epstein, I. MOSES MAIMONIDES. Anglo-Jewish essays in connection with the eighth centenary of his birth. 260 p. London, Soncino Press, 1935. ISIS

Gaos, José. La filosofía de MAIMÓNIDES, en *Revista de Occidente* 13, no. CXLI, 302-22 ; no. CXLII, 11-34. ISIS

Reviewed by J. M. V., *Al-Andalus* 3, 472-73, 1935.

Holmes, Urban T. GERALD the naturalist. *Speculum* 11, 110-21, 1936. ISIS

Apropos of GERALD THE WELSHMAN (*Introd.* 2, 417-19). G. S.

Llamas, José (O. S. A.). MAIMÓNIDES (siglo XII). 284 p. (Biblioteca de la cultura española). Madrid, 1935. ISIS

Reviewed by J. M. V., *Al-Andalus* 3, 473-74, 1935.

(Maimonides). Memorial exhibition in the Library of Congress. *Report of the Librarian of Congress*, 225-27, 1935. ISIS

Meyerhof, Max. Sur un ouvrage médical inconnu de MAIMONIDE. *Mémoires de l'Institut français*. vol. 68, 7 p., Le Caire, 1934. ISIS

Apropos du *Sharḥ al-'aqqar* (Explication de la drogue), dont un MS. a été retrouvé par HELMUT RITTER dans la bibliothèque de l'Aya Sofia, —MS. copié de la main même d'IBN AL-BAIṬAR. Analyse de ce texte et réflexions diverses. G. S.

Sarton, George. The eight hundredth anniversary of MAIMONIDES' birth. *Isis* 24, 119, 1935. ISIS

XIIIth Century (whole and first half)

Humbert, Pierre. L'astronomie au XIII^e^ siècle dans la France méditerranéenne. *Revue des questions scientifiques* 28, 201-15, 1935. ISIS

Kapp, A. G. Arabische Übersetzer und Kommentatoren EUKLIDS, sowie deren math.-naturwiss. Werke auf Grund des *Ta'rīkh al-Ḥukamā'* des IBN AL-QIFṬĪ. *Isis* 24, 37-79, 1935. ISIS

Vasiliev, A. A. The foundation of the empire of Trebizond (1204-1222). *Speculum* 11, 3-37, 1936. ISIS

XIIIth Century (second half)

Aegerter, Emmanuel. L'affaire du *De Periculis novissimorum temporum*. *Revue de l'histoire des religions* 112, 242-72, 1935. ISIS

Apropos of the famous clerical controversy referred to in my *Introd.* 2, 554, 823, 1029. G. S.

Bartholomeo of Parma (*Intr.* 2, 988). ISIS

The following correction is extracted from MARTIN GRABMANN: *Handschriftliche Forschungen und Mitteilungen zum Schrifttum des Wilhelm von Conches* (1935; *Isis* 25, 530): "Erst G. SARTON hat auf diese Abhängigkeit hingewiesen: 'A *Philosophia Boetii* must also be ascribed to him; it is nothing but an amplification of the *περὶ διδάξεων* of WILLIAM OF CONCHES.' Diese Feststellung ist nicht ganz richtig, insofern es sich hier um eine Erweiterung derjenigen *Philosophia* des WILHELM VON CONCHES handelt, die in zwei Münchener Handschriften als *Compendium philosophie Hugonis* bezeichnet ist und von der C. OTTAVIANO die zwei ersten Bücher ediert hat. Da die Bücher 4-6 dieser *Philosophia* mit Teilen des 1. Buches und mit den Büchern 2-4 der *Philosophia mundi* wörtlich übereinstimmen, trifft die Bemerkung von G. SARTON auf diese Teile zu, aber nicht in Bezug auf die beiden ersten Bücher der *Philosophia Boetii*, die eine Erweiterung und Überarbeitung der zwei ersten Bücher der pseudohugonischen *Philosophia* des WILHELM VON CONCHES sind."

Darby, George O. S. The mysterious ABOLAYS. *Osiris* 1, 251-59, 1936. ISIS

" Of all the writers who might be identified with the ABOLAYS of ALFONSO X there are four that stand out among the others : 1° MUḤAMMAD IBN AL-LAITH, 2° ABÛ'L-'ANBAS AL-ṢAIMARÎ, 3° the Shaikh ABÛ'ABDALLAH YA'ÎSH, and 4° the Qâḍi ABÛ'L-'AIS. All four must be given full consideration on account of their astrological activities."

Thompson, Daniel V., jr. The Liber Magistri PETRI DE SANCTO AUDEMARO de coloribus faciendis. *Technical studies* 4, 28-33, 1935. ISIS

Weindler, Friedrich. Deutsche Volksmedizin in der " Manesse-Handschrift." (Pal. Germ. 848). *Klinische Wochenschrift* 14, 12 p., 5 fig., 1935. ISIS

" Die althistorische Limmatstadt *Zürich* gilt heute wieder als ihre wirkliche Geburtsstätte. Hier waren tatsächlich der Ritter RÜDEGER MANESSE (gest. 5. September 1304) und sein Sohn JOHANNES, die man im 19. Jahrhundert unbegreiflicherweise für ' nicht sonderlich verständig ' und für ' kritiklos ' hielt, die Sammler der Lieder und Auftraggeber mindestens des Grundstockes der Bilder."

XIVth Century (whole and first half)

Klibansky, Raymund. Magistri ECKARDI Opera Latina auspiciis Instituti Sanctae Sabinae ad codicum fidem edita. I. Super oratione dominica, XVI+17 p. Lipsiae, MEINER, 1934. ISIS

Reviewed by SAMUEL KURLAND, *Isis* 24, 134-36, 1935.

Thorndike, Lynn. PETER OF ABANO and the Inquisition. *Speculum* 11, 132-133, 1936. ISIS

" Further light is perhaps shed on the vexed question of the relations with the Inquisition of PETER OF ABANO, the famous physician and professor at Padua, by a passage in *De rerum praenotione* of GIOVANNI FRANCESCO PICO DELLA MIRANDOLA, nephew of the more noted PICO. Writing about 1502 and alluding to the popular belief that the Conciliator (i.e., PETER OF ABANO) had commanded the services of demons, FRANCESCO affirms that he had seen the records of the procedure by the inquisitor of heretical depravity against PETER when he was accused of impiety."

Welborn, Mary Catherine. Studies in medieval metrology. The *De ponderibus et mensuris* of DINO DI GARBO (d. 1327). *Isis* 24, 15-36, 1935. ISIS

XIVth Century (second half)

Borchert, Ernst. Die Lehre von der Bewegung bei NICOLAUS ORESME. XVI+112 p. (*Beiträge zur Geschichte der Philosophie und Theologie des Mittelalters*, 31, H. 3). Münster in Westfalen, Aschendorffsche Verlagsbuchhandlung, 1934 (Rm. 4.20). ISIS

Munich thesis prepared under the direction of Profssrs. GEYSER and HÖNIGSWALD. It includes a biography and bibliography of ORESME, a study on Aristotelian and scholastic theories of movement and impetus, and finally a more elaborate analysis (pp. 46-111) of ORESME's own theories. I shall have opportunities of discussing these difficult theories in the third volume of my *Introduction*, and of referring again to BORCHERT's investigations. Meanwhile I am glad to draw the reader's attention to them. G. S.

Carswell, Catherine. "LOLLIUS myn autour." *Times Literary Supplement*, p. 899, December 28, 1935. ISIS

"Few questions of literary history, I suppose, have been debated at more length and with less result than the relations of CHAUCER and BOCCACCIO. CHAUCER's debt is written widely in his works. Yet he never mentions BOCCACCIO in acknowledgment, and where we should expect the name BOCCACCIO he gives us the name 'LOLLIUS.' Why?"

XVth Century (whole and first half)

Sigerist, Henry E. A 15th century text on the medicinal virtues of madder (*rubia tinctorum*). *Bulletin of the institute of the history of medicine* 4, 57-60, 1936. ISIS

XVth Century (second half)

Karpinski, Louis C. The first printed arithmetic of Spain; FRANCESCH SANCT CLIMENT, *Suma de la art de arismetica Barcelona*, 1482. *Osiris* 1, 411-20, 2 fig., 1936. ISIS

Description of that book with extracts thereof. G. S.

Major, Ralph H. ANTONIO DI PAGOLO BENIVIENI (1443-1502). *Bulletin of the Institute of the history of medicine* 3, 739-55, 5 fig., 1935. ISIS

Ménétrier, Pierre. De l'ancienneté de la syphilis dans le vieux monde et des lésoins caractéristiques qui en sont rapportées dans les écrits des médecins grecs. *Bull. de la soc. franç. d'hist. de la méd.* 29, 274-84, 1935. ISIS

Prowse, G. R. F. JOHN CABOT's landfall. *London Times Literary Supplement*, p. 770, November 23, 1935. ISIS

Sarton, George. Preface to volume XXIV : NUNO GONÇALVES. *Isis* 24, 7-14, 1935. ISIS

" However long the teachers of the history of art may delay in recognizing his importance, I hope, that there will be—thanks to *Isis*—a few more people who will not think any more of HENRIQUE O NAVEGADOR and of LUIZ DE CAMÕES without thinking at the same time of one who was their equal in another field, the equal of the greatest of his kind, NUNO GONÇALVES."

Streicher, Fritz. Die KOLUMBUS-Originale (eine palaeographische Studie). Gesammelte Aufsätze zur Kulturgeschichte Spaniens. *Spanische Forschungen der Görresgesellschaft* 1, 196-250, pl. Münster in Westfalen, 1928. ISIS

Reviewed by GEORGE E. NUNN, *Isis* 24, 136-41, 1935.

Süheyl, A. Sur un manuscrit médical illustré du XV^e^ siècle (Traité de chirurgie). *Comptes rendus du IX Congrès international d'histoire de la médecine*, p. 3-7, illus. Bucarest 1932. ISIS

" J'ai l'honneur de vous parler d'un livre de médecine turc, écrit il y a 467 ans, par SABOUNJOUOGLOU-CHEREFEDDINE-IBN-ALI, médecin de l'hôpital d'Amassia. Nous avons peu de chose à dire sur l'auteur. Nous savons seulement qu'il était l'élève de BURHANEDDINE-AHMED, disciple lui-même de LOCKMAN HARZÉMI, tous les deux de nationalité turque. Il est resté jusqu'à l'âge de 65 ans, et pendant 14 années consécutives, médecin de l'hôpital d'Amassia. C'est le premier auteur qui ait écrit des ouvrages médicaux en langue turque, au lieu de se servir de l'arabe ou du persan comme ses prédécesseurs. Il composa le manuscrit qui nous occupe à l'âge de 63 ans. Mais nous possédons de lui deux autres ouvrages. L'un écrit à 65 ans, a pour titre : Le Formulaire thérapeutique. Il comprend 17 chapitres, et j'en ai trouvé deux exemplaires aux bibliothèques d'Aya-Sofia et de Hamidié. L'autre est une traduction de la Matière médicale d'HARZÉMICHAH. On peut le consulter à la bibliothèque de Kilidj-Ali-Pacha. On ne sait quand Tabib CHEREFEDDINE est mort, ni où se trouve son tombeau. Le titre du manuscrit dont je veux vous parler est '*Kitabul djerrahiyeï ilhaniyé*' avec le sous-titre... (Traité de chirurgie illustre)."

Temkin, Owsei. Rare books in the Welch medical library : 2. Old manuscript prescriptions in a copy of CELSUS, Venice, 1497. *Bulletin of the institute of the history of medicine* 4, 159-64, 3 fig., 1936. ISIS

Thorndike, Lynn. COELESTINUS's summary of NICOLAS ORESME on marvels: A fifteenth century work printed in the sixteenth century. *Osiris* 1, 629-35, 1936. ISIS

"The work of COELESTINUS does not pretend to much originality but discusses whether there are influences from the stars, whether they can be measured by us, and the causes of apparent marvels, in all this following the authority of 'that great student of philosophy, NICOLAS ORESME,' whom COELESTINUS regards as almost his contemporary, although ORESME actually flourished during the second half of the fourteenth century. COELESTINUS intends to condense ORESME's argument, and his own work covers only some thirty-six leaves."

Thorndike, Lynn. CONRAD HEINGARTER in Zurich manuscripts, especially his medical advice to the Duchess of Bourbon. *Bulletin of the Institute of the history of medicine* 4, 81-87, 1936. ISIS

XVIth Century (whole and first half)

B. — *Physical sciences and technology*

Ginzburg, Benjamin. The scientific value of the Copernican induction. *Osiris* 1, 303-13, 1936. ISIS

"In any attempt to appreciate the characteristic differences between ancient and modern science, the promulgation of the Copernican theory of the heavens may serve as a sort of *experimentum crucis*, since as it happens no new empirical facts were involved in the passage from the Ptolemaic to the Copernican theory and the differences in the theories must be ascribed entirely to the difference in systematic approach."

Ionides, S. A. CAESARS' astronomy (*Astronomicum Caesareum*), by PETER APIAN, Ingolstadt 1540. *Osiris* 1, 356-89, 6 pl., 1936. ISIS

Description and discussion of the *Astronomicum Caesareum*, 1540. G. S.

Michel, Henri. L'art des instruments de mathématiques en Belgique au XVI^e^ siècle. *Bull. soc. royale d'archéol. de Bruxelles*, Nr. 2, 19 p., 10 fig., 1935. ISIS

Partington, J. R. VANNUCCIO BIRINGUCCIO (early 16 cent.). *Isis* 24, 121, 1935. ISIS

C. — *Natural sciences*

Arber, Agnes. A recent discovery in sixteenth century botany. *Nature* 137, 258, 1936. ISIS

Apropos of WALTHER RYTZ's studies on the herbal of FELIX PLATTER (1536-1614) and on the water colors of plants by HANS WEIDITZ, 1529. G. S.

D. — *Medical sciences*

Diepgen, Paul. PARACELSUS, 1493-1541. Die Grossen Deutschen, neue Deutsche Biographie 520-31 (no date). ISIS

Glümer, H. v. Die Kuren des Meisters HERMAN V. MÖRS. Aus dem Akten des Archivs der Stadt Braunschweig. *Sudhoffs Archiv für Geschichte der Medizin* 28, 362-64, 1935. ISIS

Pellegrini, Francesco. Frammento inedito di GEROLAMO FRACASTORO riguardante la pestilenza del 1534-35. *Rivista di storia delle scienze mediche* 26, 353-59, 1935. ISIS

Schlueter, Robert E. PARACELSUS (THEOPHRASTUS BOMBAST VON HOHENHEIM, 1493-1541). *Interstate medical journal* 19, 9 p., 3 fig., 1912. ISIS

Uhlig, P. Fahrende Ärzte. *Sudhoffs Archiv für Geschichte der Medizin* 28, 264-66, 1935. ISIS

E. — *Alia*

Valton, Emilio. Impresos Mexicanos del siglo XVI (Incunables Americanos). XXXI+244 p., 52 illus. (Ediciones de la Biblioteca nacional de México). México, Imprenta Universitaria, 1935. ISIS

Dr. VALTON has made a fundamental contribution to the early history of printing in the Americas. His study opens with an introductory discussion of the origin of printing in America. The first book to appear was the *Breve y más compendiosa doctrina Christiana en lengua castellana y mexicana*, México, 1539. The earliest publishing seems to have been by JUAN CROMBERGER of Sevilla, and JUAN PABLOS. A careful analysis is made of the chief items appearing from the leading Mexican presses to the end of the 16th century and through the first few years of the 17th century. The books published include all sorts with a fair sprinkling of items relating to various aspects of science and medicine. Dr. VALTON describes each item with meticulous care. The whole study is fundamental for an understanding of early publishing in the New World. C. D. L.

XVIth Century (second half)

A. — *Mathematics*

Ockenden, Ralph E. JEAN TRENCHANT, French mathematician of the second half of the sixteenth century (*Isis* 21, 207-9, 1934). *Answer no.* 38, *Isis* 24, 113, 1935. ISIS

B. — *Physical sciences and technology*

Johnson, Francis R. The influence of THOMAS DIGGES on the progress of modern astronomy in sixteenth-century England. *Osiris* 1, 390-410, 1936. ISIS

"In England, perhaps more than in any other country, an intelligent knowledge of the Copernican theory was spread among all classes of practical scientific workers before 1600, and nowhere was there a keener interest in the implications of the new astronomy, or a more earnest search for a satisfactory physical explanation of various features of the Copernican hypothesis. This active interest in the Copernican astronomy was due largely to the work and influence of THOMAS DIGGES, the most eminent astronomer and mathematician of Queen ELIZABETH's reign."

E. — *Alia*

Bloch, Joshua. Hebrew printing in Riva di Trento. *Bulletin of the New York Public Library*, 15 p., illus., Sept. 1933. ISIS

"The printing of Hebrew books in Riva di Trento lasted but a brief span of time—merely four years (1558-1562)—but, the output, while not large in number, only about thirty-five titles, is characterized by a definite leaning toward the publication of philosophical texts and of works which present rational interpretations of Jewish beliefs and practices. The character of the books and the manner of their production contributed much to the fact that the achievements of the Hebrew press in Riva di Trento left a lasting impression on the history of Hebrew typography."

Plimpton, George A. The education of SHAKESPEARE. Illustrated from the schoolbooks in use in his time. 146 p., facsimiles, frontispiece. London, Oxford University Press, 1933. ISIS

Preface: "It has been my privilege to get together the manuscripts and books which are more or less responsible for our present civilization, because they are the books from which the youth of many centuries have received their education. From this collection I have picked out the textbooks in use at the time that SHAKESPEARE was in school. All the books from which I quote are on my own shelves. There are others, but I have confined this study to my own collection. I do not pretend to have made any study of the various controversies about SHAKESPEARE, I do not profess to be a Shakespearean scholar; but I happen to own some books which are of interest to scholars, and I feel competent to give a simple and informal description of them." Abundant illustrations. G. S.

Wood, Casey A. JOHANNES BAPTISTA PORTA (1540-1615). Neapolitan oculist and natural philosopher. *Proceedings of the Charaka Club*, 118-34, 6 fig., 1935. ISIS

XVIIth Century (whole and first half)

A. — *Mathematics*

Sanford, Vera. FRANÇOIS LE GENDRE, arithmeticien. *Osiris* 1, 510-18, 1936. ISIS

Died c. 1675. Popular textbook writer. G. S.

Stamm, Edward. Z historji matematyki XVII w. w Polsce. III+206+11 p. (Osobne Odbicie z T. 40, Wiadomości Matematycznych). Warszawa 1935 (in Polish). ISIS

Elaborate studies on Polish mathematics in the seventeenth century, dealing with materials which have been overlooked or which were entirely unknown. The author has made use of many MSS kept in the Polish archives. We hope to publish later on an analysis of it. G. S.

B. — *Physical sciences and technology*

Bernard, Henri (S. J.). GALILÉE et les Jésuites des missions d'orient. *Revue des questions scientifiques* 28, 356-82, 1935. ISIS

Conclusion : " Il peut sembler surprenant que des jésuites, si délibérément hostiles aux théories de COPERNIC, aient su profiter si habilement et divulguer si complètement les découvertes astronomiques du début du XVII[e] siècle. L'énigme se résout facilement quand on distingue dans l'œuvre de GALILÉE, les faits et les théories. Ce qui était important pour les réformateurs du calendrier chinois, c'était presque uniquement les faits et les instruments : ils s'en servirent abondamment. Quant aux théories, elles n'étaient pratiquement utiles qu'à titre d'hypothèses pour diriger dans les calculs, et les Chinois qui ne pouvaient connaître de la géométrie que ce qui concerne les lignes droites, les triangles et le cercle (à l'exclusion des sections coniques : ellipse, hyperbole et parabole), étaient incapables alors de comprendre les lois de KEPLER. D'ailleurs, hypothèse pour hypothèse, les jésuites d'Orient qui sentaient combien devenait fragile le système suranné de PTOLÉMÉE, pouvaient s'abriter derrière le nom d'un astronome universellement réputé pour introduire les changements compatibles avec ce que l'on croyait être le sens des Écritures. Ils exposèrent la doctrine cosmologique de TYCHO-BRAHÉ. Le P. BRUNO, que nous avons vu professer des opinions hardies sur les trois cieux ' liquides,' avait porté son savoir scientifique jusqu'en Indochine, où il prédit exactement deux éclipses; en 1624, on le retrouve à Goa, où le voyageur PEDRO DE VALLE traduit en persan son traité ' sur la nouvelle constitution du monde d'après le système de TYCHO-BRAHÉ et d'autres modernes.' C'est sans doute pour le même motif que les jésuites de Pékin utilisèrent surtout, en ces débuts, les Tables astronomiques de LANSBERG, basées sur l'hypothèse tychonienne. En Europe, NEWTON, par sa découverte de l'attraction universelle, corrigea

certaines erreurs de GALILÉE (par exemple sa théorie des marées) et renforça les preuves de ses vérités. Il devint de plus en plus clair que l'Écriture sainte s'exprimait simplement d'après les conceptions courantes, sans prétendre juger en matières scientifiques. Les jésuites de Chine voulurent alors enseigner expressément le système de GALILÉE; ainsi le P. BENOÎT écrit (12 octobre 1764) qu'en 1761 il a présenté à l'Empereur KIEN-LONG une mappemonde : ' Dans mon explication j'y ai exprimé assez au long le système de COPERNIC qu'il s'en faut bien que les Chinois n'aient encore adopté... Après bien des séances, malgré bien des oppositions de la part des gens du tribunal.. l'Empereur ordonna qu'on corrigerait les différents globes du palais et qu'on y ajouterait les nouvelles découvertes.' Cette décision ne dut guère franchir l'enceinte de la demeure impériale, car le vieux petit manuel du P. MANUEL DIAZ, somme abrégée de la doctrine ptoléméenne, demeura la source presque unique d'information pour les ' savants ' de Chine. Ce fut seulement plus d'un siècle après, lorsque les *Éléments d'Euclide* eurent été imprimés au complet (1865), que les principes de GALILÉE et de KEPLER purent se divulguer en Extrême-Orient."

De Waard, C. Notes sur STEVIN et BEECKMAN. *Isis* 24, 123-25, 1935. ISIS

Eve, A. S. GALILEO and scientific history. The leaning tower and other stories. *Nature* 137, 8-10, 1936. ISIS

Helmontiana. *Le folklore brabançon*, 15, 259-61, 1935-36. ISIS

Nève de Mévergnies, Paul. JEAN-BAPTISTE VAN HELMONT, philosophe par le feu. 232 p. (*Bibliothèque de la Faculté de philosophie et lettres de l'Université de Liége*, fasc. 69). Liége, DROZ, 1935. ISIS

Read, John. A musical alchemist. (Abstract). 9 p., 2 pl. Royal Institution of Great Britain, weekly evening meeting, Friday, November 22, 1935. ISIS

Mainly apropos of MICHAEL MAIER (1568-1622). " Besides being an alchemist, he was also a philosopher, a mystic, an exponent of Rosicrucianism, a physician, a classical scholar, and a musician. He was called to Prague by the Emperor RUDOLPH II, who made him his physician and private secretary, and raised him to the rank of Count Palatine. The publishing firm of LUCAS JENNIS of Frankfurt took a prominent part in issuing MAIER's works, and it is worthy of note that the dominating feature in his writings is an alchemical interpretation of Egyptian and Greek mythology. MAIER's emblems are often provided with a Latin epigram, together with a cryptic title and a discourse in the same language. ' Atalanta Fugiens,' or ' Atalanta Fleeing,' published by MAIER at Oppenheim in 1618, contains fifty such epigrams, written in elegiac couplets and set to music, apparently by the versatile author. It might be presumed that these ' incantations ' were intended to be sung at critical moments during the coction of the Philosopher's Stone, such operations being directed also by prayer and astrological influences;

but to what extent MAIER, or other alchemists, endeavoured to influence their laboratory operations by means of music is not clear." (p. 5). After this lecture, the "alchemical music" was explained by F. H. SAWYER lecturer in music and Prof. READ's colleague in St. Andrews) and examples were sung under his direction by a company of fifteen students of the St. Andrews University Choir. G. S.

Vaccaro, Leopold. GALILEO GALILEI. *Annals of medical history* 7, 372-84, 1935. ISIS

Vollgraff, J. A. SNELLIUS' notes on the reflection and refraction of rays. *Osiris* 1, 718-25, 2 fig., 1936. ISIS

Wiener, Philip Paul. The tradition behind GALILEO's methodology. *Osiris* 1, 733-46, 1936. ISIS

Conclusion : "Just as EUCLID, ARCHIMEDES and GALILEO used ARISTOTLE's logic as an instrument for the investigation of nature and not as an independent source or guarantee of truth, so the lesson to be drawn from our study of GALILEO is to guard ourselves against the sterilization of thought that comes from the study of logic divorced from specific subject-matter; that is to say, logic has its scientific use as an instrument of research rather than merely as a rhetorical weapon for restricting research through falsely assuming dead finality. Experiment in the methodology of GALILEO and modern science as in PLATO and ARISTOTLE, shows only how closely we can approximate the conclusions reached by analysis."

E. — *Alia*

Cohen, Leonora D. DESCARTES and HENRY MORE on the beast-machine. A translation of their correspondence pertaining to animal automatism. *Annals of science* 1, 48-61, 1936. ISIS

Dally, Ph. A propos d'un livre de M. HARCOURT BROWN sur les organisations scientifiques en France au XVII^e^ siècle. *Bull. de la soc. franç. d'hist. de la méd.* 29, 285-94, 1935 ISIS

Gabrieli, Giuseppe. Per la storia della prima romana accademia dei Lincei. *Isis* 24, 80-89, 1935. ISIS

Merton, Robert K. Puritanism, pietism, and science. *Sociological review* 28, 30 p., 1936. ISIS

"It is the thesis of this study that the Puritan ethic, as an ideal-typical expression of the value-attitudes basic to ascetic Protestantism generally, so canalized the interests of seventeenth-century Englishmen as to constitute one important element in the enhanced cultivation of science. The

deep-rooted religious *interests* of the day demanded in their forceful implications the systematic, rational, and empirical study of Nature for the glorification of God in His works and the control of the corrupt world."

Sarton, George. Third centenary of the death of HSÜ KUANG-CH'I (1562-1633). *Isis* 24, 122-23, 1935. ISIS

XVIIth Century (second half)

A. — *Mathematics*

Archibald, R. C. WALLIS on the Trinity. *American mathematical monthly* 43, 35-37, 1936. ISIS

Apropos of JOHN WALLIS: *The doctrine of the blessed Trinity* (London 1690). G. S.

Larmor, Joseph. NEWTON and GREGORY. *London Times Literary Supplement*, p. 55, January 18, 1936. ISIS

Mahnke, Dietrich. Neue Einblicke in die Entdeckungsgeschichte der höheren Analysis. *Abhandlungen der preussischen Akademie der Wissenschaften, physikalisch-mathematische Klasse*, Nr. 1, 64, p., 4 pl. Berlin, 1925. ISIS

More, Louis Trenchard. ISAAC NEWTON. A biography. XII+675 p. New York, SCRIBNER'S, 1934. ISIS

Reviewed by JEAN PELSENEER, *Isis* 24, 141-43, 1935.

Pelseneer, Jean. Une lettre inédite de NEWTON à PEPYS (23 décembre 1693). *Osiris* 1, 497-99, 1936. ISIS

Letter concerning calculus of probabilities. G. S.

Sergescu, P. Les mathématiques dans le *Journal des savants*, première période 1665-1701. *Osiris* 1, 568-83, 1936. ISIS

B. — *Physical sciences and technology*

Edwards, W. N. ROBERT HOOKE as geologist and evolutionist. *Nature* 137, 96-97, 1936. ISIS

Hiscock, W. G. The war of the scientists. New light on NEWTON and GREGORY. *Times Literary supplement*, p. 34, January 11, 1936. ISIS

Huygens, Christiaan (1629-14 April-1929). Zijn geboortedag, 300 jaar geleden, herdacht. 61 p., 12 pl. Amsterdam, PARIS, 1929. ISIS

Handsome booklet published to celebrate the third centenary of HUYGENS' birth. It includes Dutch speeches by L. VAN ITALLIE, C. VAN VOLLENHOVEN, P. ZEEMAN, A. F. HOLLEMAN and a French one by E. PICARD. An article on HUYGENS' habitations in The Hague and Voorburg by J. H. PLANTENGA, and a catalogue of the HUYGENS' exhibition in Leiden by C. A. CROMMELIN and J. A. VOLLGRAFF. G. S.

Partington, J. R. The early history of phosphorus. *Science progress*, no. 119, 402-12, 1936. ISIS

Patterson, T. S. RICHARD BOYLE, Esq., M. P., F. R. S., and —incidentally—some of his relatives. *Annals of science* 1, 62-65, 1936. ISIS

A nephew of ROBERT BOYLE and an original fellow of the Royal Society. Born c. 1641; he was an officer on H. M. S. Royall Charles and was killed at the naval Battle of Soleboy with the Dutch in 1665. G. S.

Walker, Helen M. An unpublished hydraulic experiment of ROBERVAL, 1668. *Osiris* 1, 726-32, 1 facs., 1936. ISIS

After a MS in the D. E. Smith Library, "How to make the bellows of a forge by means of water, an experiment; ROBERVAL, September 5, 1668," translated into English with notes and facsimile. G. S.

C. — *Natural sciences*

Sarton, George. Letters from and to ANTONY VAN LEEUWENHOECK (1632-1723). *Query* 49. *Isis* 24, 103, 1935. ISIS

D. — *Medical sciences*

Hallema, A. Een medisch rapport in brieven over de verwonding en het overlijden van den frieschen stadhouder WILLEM FREDERIK, prins van Nassau, anno 1664, 31 october. *Bijdragen tot de geschiedenis der geneeskunde* 15, 213-20, 1935. ISIS

Hurd-Mead, Kate Campbell. Mme FOUQUET's prescription book (1685). *Medical life* 42, 623-27, 1935. ISIS

Van Andel, M. A. De chirurgijn CORNELIS SOLINGEN en zijn instrumentarium. *Bijdragen tot de geschiedenis der geneeskunde* 16, 10-18, 3 pl., 1936. ISIS

E. — *Alia*

Andrade, E. N. da C. The real character of Bishop WILKINS. *Annals of science* 1, 4-12, 4 fig., 1936. ISIS

Holthouse, E. H. LEIBNIZ as historian. *London Times literary supplement*, p. 746, November 16, 1935. ISIS

Hornberger, Theodore. SAMUEL LEE (1625-1691), a clerical channel for the flow of new ideas to seventeenth-century New England. *Osiris* 1, 341-55, 1936. ISIS

"These facts do not show that LEE's influence in New England was direct or revolutionary. What they do suggest is that the stage of thought which appears in his books also appears in New England at approximately the time of his arrival. He was only one of a number of immigrants who came to Massachusetts in the last quarter of the century. He stayed for five years only, dying in France in 1691 after the ship on which he had sailed to England had been captured by privateers. It is probable, however, that through him, and through others like him, the flow of ideas to New England was quickened by the personal touch. No BOYLE or GLANVILL, he was nevertheless deeply tinged with the intellectual color of their age. His life and works reveal the almost unexplored complexity of the channels by which ideas of pre-Newtonian science and philosophy came to colonial America."

XVIIIth Century (whole and first half)

A. — *Mathematics*

Karpinski, Louis C. The elusive GEORGE FISHER "accomptant"—writer or editor of three popular arithmetics. *Scripta mathematica* 3, 337-39, 1935. ISIS

B. — *Physical sciences and technology*

Crommelin, C. A. Die holländische Physik im 18. Jahrhundert mit besonderer Berücksichtigung der Entwicklung der Feinmechanik. *Sudhoffs Archiv für Geschichte der Medizin* 28, 129-42, 1935. ISIS

Menschutkin, B. N. The thermometer scale of DE L'ISLE. *Nature* 137, 34, 1936. ISIS

Pabst, Adolf. CHARLES-FRANÇOIS DU FAY, pioneer in crystal optics. *American mineralogist* 17, 569-72, 1932. ISIS

Walker, W. Cameron. The detection and estimation of electric charges in the eighteenth century. *Annals of science* 1, 66-100, 8 pl., 8 fig., 1936. ISIS

C. — *Natural sciences*

Golder, Frank Alfred (1877-1929). BERING's voyages : an account of the efforts of the Russians to determine the relation of Asia and America. Vol. I : The log books and official reports of the first and second expeditions, 1725-1730 and 1733-1742. With a chart of the second voyage, by Captain E. P. BERTHOLF. Vol. 2 : G. W. STELLER's Journal of his sea voyage from Kamchatka to America on the second expedition. Translated and edited by F. A. GOLDER and LEONHARD STEJNEGER. (*Research series*, 1 and 2). New York, American Geographical Society, 1922 and 1925 (reprinted 1935). ISIS

Reviewed by E. RAISZ, *Isis* 24, 146-49, 1935.

Hanke, Michael ; Degner, Hermann. Die Pflege der Kartographie bei den königlich preussischen Akademie der Wissenschaften unter der Regierung FRIEDRICHS des Grossen. Mit einem Vorworte und Beiträgen von ALBRECHT PENCK. *Abhandlungen der preussischen Akademie der Wissenschaften, physikalisch-mathematische Klasse*, 2, 68 p., Berlin, 1934. ISIS

Sarton, George. A propos de la soie d'araignée et des traductions chinoises. *Query* no. 50, *Isis* 24, 103-06, facs., 1935. ISIS

D. — *Medical sciences*

Heischkel, Edith. Die Beiträge der Berliner Charitéärzte zur medizinischen Literatur des 18. Jahrhunderts. *Klinische Wochenschrift* 15, 6 p., 1936. ISIS

Osman, Rifat. Sur l'inoculation antivariolique au XVIII[e] siècle. Comptes rendus du IX congrès international d'histoire de la médecine p. 3-4, Bucarest, 1932. ISIS

XVIIIth Century (second half)

A. — *Mathematics*

Batchelder, P. M. WARING's problem (1770). *American mathematical monthly* 43, 21-27, 1936. ISIS

Hellman, C. Doris. LEGENDRE and the French reform of weights and measures. *Osiris* 1, 314-40, 2 facs., 1936. ISIS

Sarton, George. MONTUCLA (1725-1799). His life and works. *Osiris* 1, 519-67, 11 fig., 1 pl., 1936. ISIS

"Contents: §§ 1-6. MONTUCLA's life. § 7. Chronology of his writings and main events. §§ 8-38. His works, in chronological order. § 39. Final appreciation. § 40. Bibliography. § 41. Iconography. § 42. Thanks. §§ 43-45. Appendix. Two unpublished documents concerning MONTUCLA. § 46. Index. Illustrations: Portrait, two autographs, and ten other documents in facsimile."

Simons, Lao G. Eighteenth century algebra in America. *Scripta mathematica* 3, 355-56, 1935. ISIS

Ver Eecke, P. Le traité des hosoèdres de VITO CARAVELLI (1724-1800), traduit sur le texte latin original. *Mathesis* 49, 59-62, 1935. ISIS

B. — *Physical sciences and technology*

Bathe, Greville; Bathe, Dorothy. OLIVER EVANS: A chronicle of early American engineering. Philadelphia, Historical Society of Pennsylvania, 1935 ($12). ISIS

"OLIVER EVANS (1755-1819) was one of the first to see the great potentialities of steam and its part in the making of the nation." ... "He was the first to depart from the Newcomen atmospheric steam engine and to apply high pressures. He was the first in America to move a vehicle on land under steam power. He wrote a standard text-book for millers and mill-wrights which went through fifteen editions and is still used in some sections."

Dickinson, H. W. JAMES WATT: Craftsman and engineer. XVI+207 p., 17 pl. Cambridge, University Press, 1936. ISIS

Reviewed in *Nature* 137, 129, 1936.

Labilliere, P. F. D. de. WATT commemoration Westminster Abbey. *Nature* 137, 133-35, 1936. ISIS

McKie, Douglas. On THOS. COCHRANE's MS. notes of BLACK's chemical lectures, 1767-8. *Annals of science* 1, 101-10, 1 pl., 1936. ISIS

Sarton, George. The chemist ANDRÉ ETIENNE (fl. 1794). *Query* no. 48. *Isis* 24, 102, 1935. ISIS

Answer no. 48.1 by F. SZINNYEI (*Isis* 24, 114). Answer no. 48.2 by VALERIU BOLOGA (*Isis* 24, 115-18).

Seydl, Otto. Die Geschicke eines Chronometers der Königl. Böhmischen Gesellschaft der Wissenschaften in Prag (1791-1864). Ein Beitrag zur Geschichte der Naturwissenschaften in Böhmen. 89 p. (Publikace pražské státní hvězdárny. Č. 8. Publications de l'Observatoire national de Prague). Prague, GRÉGR., 1935. ISIS

" Es handelt sich um ein Chronometer aus der Werkstätte des Künstlers JOSUA EMERY, eines in London ansässigen Schweizers." " Die Geschicke dieses Chronometers sind darum interessant, weil mit seiner Hilfe eine Reihe von astronomischen Vermessungen in Böhmen und Mähren zu Ende des 18. und in der ersten Hälfte des 19. Jahrhunderts durchgeführt wurde, und auch darum, weil es den indirekten Anlass eines Streites zwischen der Kgl. Böhmischen Gesellschaft der Wissenschaften und Baron ZACH bildete."

(Watt, James, Jan. 19, 1736-Aug. 25, 1819). The program of the WATT bicentenary in the United States, January 19, 20, 21, 1936. Lehigh University, The Franklin Institute of the State of Pennsylvania, The American Society of Mechanical Engineers, The Newcomen Society of England. ISIS

(Watt, James). The WATT bicentenary celebrations. *Nature* 137, 131-33, 1936. ISIS

Zekert, Otto. CARL WILHELM SCHEELE, sein Leben und seine Werke. Index, pt. 1-7, 16 p. *Gesellschaft für Geschichte der Pharmazie*, 1935. ISIS

C. — *Natural sciences*

Osborn, Henry Fairfield (1857-1935). THOMAS JEFFERSON as a paleontologist. *Science* 82, 533-38, 1935. ISIS

Seybert, Adam. The Adam Seybert mineral collection. *Science* 83, 49, 1936. ISIS

" The first mineral collection formed in America, made in the 1790's by Dr. ADAM SEYBERT of Philadelphia, has been put on exhibit in the Free Natural History Museum of the Academy of Natural Sciences of Philadelphia. This ' beginning of mineralogy ' in the United States contains 1,725 specimens of rocks and crystals, and is shown in the original cabinet built for it by Dr. SEYBERT, and as he arranged it."

D. — *Medical sciences*

Garosi, A. Sui rapporti di amicizia di PAOLO MASCAGNI col medico NICOLÒ SEMENSI ed una lettera inedita del Grande anatomico. *Rivista di storia delle scienze mediche* 26, 366-77, 1935. ISIS

Meyer, Arthur William. Mr. JOHN HUNTER on generation. 57 p. *California and Western medicine*, 43, nos. 2, 3, 4, 5, 1935. ISIS

Monteiro, Arlindo Camilo. Les doctrines médicales de WILLIAM CULLEN (1712-90) au Portugal. *Archeion* 17, 176-202, 1935. ISIS

E. — *Alia*

Bessmertny, Bertha. VOLTAIRE historien des sciences, *Archeion* 17, 171-75, 1935. ISIS

Boatner, Charlotte H. Certain unpublished letters from French scientists of the Revolutionary period taken from the files of JOSEPH LAKANAL. *Osiris* 1. 173-83, 1 facs., 1936. ISIS

Goodrich, Luther Carrington. The literary inquisition of CH'IEN-LUNG. XII+275 p. (American council of learned societies : Studies in Chinese and related civilizations, 1). Baltimore, Waverly Press, 1935 ($2.50). ISIS

"From 1774 to 1778, while he was assembling books for the Imperial library Ssu-k'u Ch'üan Shu, the Emperor CH'IEN-LUNG made a determined effort to stamp out all Chinese literature which seemed to reflect on his house or on the Manchus and other northern peoples. The subject of this monograph is what lay back of this attempt and how far it was successful. The study is fully documented with translations from the sources, and there are useful appendices, including a list of works saved from the inquisition." Reviewed by CARROLL B. MALONE, *Journal of the American Oriental society* 55, 477-79, 1936.

Kant, Immanuel. Religion within the limits of reason alone. Translated with an introduction and notes by THEODORE M. GREENE and HOYT H. HUDSON. Chicago, Open Court, 1934. ISIS

Reviewed by D. W. PRALL, *Isis*, 24, 143-45, 1935.

XIXth **Century** (whole and first half)

A. — *Mathematics*

Geppert, Harald ; Dunnington, G. Waldo. "GAUSS's *Disquisitiones*

arithmeticae and the Russian Academy of Sciences." *Scripta mathematica* 3, 356-58, 1935. ISIS

Loria, Gino. MICHELE CHASLES e la teoria delle sezioni coniche. *Osiris* 1, 421-50, portrait, 1936. ISIS

Contents: 1. Origine e primo stadio di sviluppo della teoria delle coniche; 2. Le coniche dopo il Rinascimento; 3. Le coniche come trajettorie descritte dagli astri e come rappresentate da equazioni fra coordinate cartesiane; 4. Rinascita della geometria: MONGE e PONCELET; 5. Memorie giovanili di CHASLES sulla teoria delle coniche; le coniche omotetiche; 6. Prima comparsa di metodi generali di ricerca negli scritti di CHASLES; 7. Applicazioni della polarità; 8. Le coniche nell' "Aperçu historique"; 9-10. Nuovi punti di vista introdotti da CHASLES nello studio delle sezioni coniche; 11. Le linee congiunte rispetto ad una conica; 12. Archi di una conica a differenza retificabile. Poligoni di perimetri massimi o minimi inscritti o circoscritti ad una conica; 13. Nuova rappresentazione geometrica della teoria delle funzioni ellittiche; 14. Generalizzazione della teoria dei fuochi di una conica. Proprietà di certi sistemi di diametri di una tale curva; 15. Intermezzo; 16. La teoria delle caratteristiche dei sistemi costituiti da ∞ coniche di un piano; 17. Estensione allo spazio della teoria delle caratteristiche; 18. Il "Traité des sections coniques". Chiusa.

B. — *Physical sciences and technology*

Berzelius, Jöns Jacob. Autobiographical notes, published by the Royal Swedish Academy of sciences through H. G. SÖDERBAUM. Translated from the Swedish by OLOF LARSELL. XI+194 p. (History of science society publications, new series 6). Baltimore, WILLIAMS & WILKINS, 1934. ISIS

Reviewed by TENNEY L. DAVIS, *Isis* 24, 149-51, 1935.

Crommelin, C. A. Over tralieplaatjes van NOBERT ter beproeving van microscopische objectieven en ter demonstratie van interferentiekleuren. *Nederlandsch tijdschrift voor natuurkunde* 1, 305-20, 1934. ISIS

Apropos of the FRIEDRICH ADOLPH NOBERT (1806-81) constructor of remarkable gratings. G. S.

Faraday, Michael. FARADAY's diary. Being the various philosophical notes of experimental investigation made by MICHAEL FARADAY, D. C. L., F. R. S., during the years 1820-1862 and bequeathed by him to the Royal Institution of Great Britain. Now, by order of the Managers, printed and published for the first time, under editorial supervision of THOMAS MARTIN. With a foreword by

Sir WILLIAM H. BRAGG. Vol. VII : Nov. 24, 1855-Mar. 12, 1862. XVII+465 p., port. Index. 64 p. London, BELL, 1936 (Price of whole work, 7 vols. plus index, twelve guineas). ISIS

This completes a magnificent monument to FARADAY's memory, begun in 1932 (*Isis* 20, 472-4). G. S.

Getman, Frederick H. SAMUEL MOREY, a pioneer of science in America. *Osiris* 1, 278-302, 1 pl., 1936. ISIS

Holmberg, Arne. Ein bis jetzt unbekannter Brief von F. WÖHLER an J. J. BERZELIUS aus dem Jahre 1847. *Mitt. z. Gesch. d. Medizin* 35, 26-7, 1936. ISIS

Lippmann, Edmund O. von. Vor hundert Jahren (XV). *Die Deutsche Zuckerindustrie*, p. 35-38 (received March 1936). ISIS

Martin, Thomas. FARADAY. 144 p. (Great lives, 40). London, DUCKWORTH, 1934. ISIS

See section XIX (2)c, note HINGSTON.

Partington, J. R. DAVY on agricultural chemistry. *Journal of the society of chemical industry* 54, 849-51, 1935. ISIS

Taylor, H. Marshall. JOHN GORRIE : physician, scientist, and inventor. *Southern medical journal* 28, 1075-1082, 1935 (President's address, Southern medical association, St. Louis, November 1935).

A delightful account of JOHN GORRIE, born in Charleston, South Carolina in 1803, graduate in medicine, College of Physicians and Surgeons, New York, practiced medicine at Apalachicola, Florida. He advocated sanitary improvements and wrote extensively on malarial fevers. In 1844, he conceived the idea of cooling the air in sick rooms and hospitals for patients with fever. He manufactured artificial ice to make this possible. Granted patent 8080 in 1851 for machine to manufacture artificial ice by rapid expansion of compressed air. Unfortunately he had no capital to develop his method. A statue to Dr. GORRIE is in Statuary Hall, Washington. C. D. L.

D. — *Medical sciences*

Autenrieth, Dr. Ein Bericht über die Tübinger Typhus-epidemie im Jahre 1816. *Sudhoffs Archiv für Geschichte der Medizin* 28, 359-61, 1935. ISIS

Beaumont, William. Centennial celebration, St. Louis medical society, November 21, 1933. *Weekly bulletin* 28, 21 p., Dec. 8 and 15, 1933. ISIS

Biró, Emerich. JOHANN THEOPHIL FABINI (1791-1847). Über den ersten ungarischen Professor der Augenheilkunde. *Sudhoffs Archiv für Geschichte der Medizin* 28, 324-37, 1935. ISIS

Castaldi, Luigi. Discorso per la traslazione delle salme di FILIPPO CIVININI, FILIPPO PACINI e ATTO TIGRI nella chiesa di S. Maria delle grazie presso lo spedale del ceppo in Pistoia. *Rivista di storia delle scienze mediche* 26, 289-308, 1935. ISIS

Gafafer, William M. PETER LUDWIG PANUM's " Observations on the contagium of measles." *Isis* 24, 90-101, 1935. ISIS

Translation with notes and introduction of PANUM's classical paper of 1847 concerning the spread of measles in the Faroe Islands.

Halsey, Robert H. How the President, THOMAS JEFFERSON, and Doctor BENJAMIN WATERHOUSE established vaccination as a public health procedure. 58 p., 2 pl., facs. (History of medicine series issued under the auspices of the Library of the New York Academy of Medicine, 5). New York, the Author, 1936. ISIS

An interesting chapter of the story of the diffusion of Jennerian vaccination. The main introducer into the United States was Dr. BENJAMIN WATERHOUSE (1754-1846) who was immediately and powerfully helped by JEFFERSON. (This is another proof of JEFFERSON's scientific outlook and of his alertness when scientific matters or methods were concerned.) Dr. HALSEY's account is largely based upon unpublished documents and beautifully illustrated.
G. S.

Leibbrand, Werner. Fünf ungedruckte Briefe JUSTUS CHRISTIAN LODERS (gest. 1832) an den Dichter AUGUST V. KOTZEBUE. *Sudhoffs Archiv für Geschichte der Medizin* 28, 296-323, 1935. ISIS

Oliver, John Rathbone. An unpublished autograph letter from Dr. JOHN CRAWFORD (1746-1813) to General WILLIAM HENRY WINDER (1775-1824). *Bulletin of the institute of the history of medicine* 4, 145-51, 1936. ISIS

Radbill, Samuel X. JOHN EBERLE : A Pennsylvania Dutch pioneer in American medical education. *Bulletin of the institute of the history of medicine* 4, 121-36, 4 fig., 1936. ISIS

Schlueter, Robert E. LEWIS FIELDS LINN (1795-1843), physician and statesman. *Weekly bulletin of the St. Louis medical society* 29, 8 p., 1935. ISIS

XIXth Century (second half)

A. — *Mathematics*

Archibald, Raymond Clare. Unpublished letters of JAMES JOSEPH SYLVESTER and other new information concerning his life and work. *Osiris* 1, 85-154, 2 facs., 1936. ISIS

Contents : 1. Introductory; 2. Curriculum vitae; 3. Publications dealing with S.'s life and work; 4. S.'s first mathematical publication; 5. S. and the University of Virginia; 6. S., 1842-1855; 7. S.'s poetry; 8. Letters of S.

Hadamard, Jacques. Selecta. Jubilé scientifique de JACQUES HADAMARD. 432 p. Paris, GAUTHIER-VILLARS, 1935. ISIS

Recueil de quelques ans des travaux de l'illustre mathématicien. Une bibliographie (1886-1935) complète le volume (pp. 415-28). J. P.

B. — *Physical sciences and technology*

Conant, James B. ANDREW CARNEGIE, patron of learning. *Science* 82, 599-603, 1935. ISIS

Gliozzi, Mario. Una rivendicazione italiana : il telefono automatico. *Archeion* 16, 205-08, 1934. ISIS

Apropos of this ZAUNICK remarks in *Mitt. z. Gesch. d. Med.* (vol. 35, 131, 1936) : " Die Archiv-Verwaltung der SIEMENS & HALSKE AG u. d. Siemens-Schuckertwerke AG mit, dass sie den von GLIOZZI dargestellten Vorgang habe nachprüfen lassen. Hierbei wurde folgendes festgestellt : Das Patent der beiden Italiener ist durch ein 9 Jahre älteres amerikanisches Patent vollkommen vorweggenommen. Dieses enthält einen Grundsatz (Heben und Drehen eines Wählers), den die Firma noch heute benutzt. In dem italienischen Patent ist also dieser Grundsatz keineswegs zum ersten Male gezeigt worden. Die übrigen Anordnungen des italienischen Patentes sind für die praktische Verwendung vollkommen unbrauchbar. Damit ist der implicite vorhandene Vorwurf des Autors hinfällig, als seien die italienischen Erfinder seinerzeit von der Firma SIEMENS & HALSKE ungerechterweise totgeschwiegen worden."

Lowell, A. Lawrence. Biography of PERCIVAL LOWELL. IX+212 p., illus. New York, MACMILLAN, 1935. ISIS

This biography of the American astronomer PERCIVAL LOWELL (1855-1916) was written by his brother sometime president of Harvard University. It includes a good account of PERCIVAL LOWELL's manysided activities : studies of Japanese and Korean cultures, Japanese occultism, canals of Mars,

evolution of the planets, trans-Neptunian planet, foundation and development of the Flagstaff observatory in Arizona. LOWELL's calculations concerning a trans-Neptunian planet were vindicated in 1930 by the discovery of Pluto, " the planet he found but never saw." His astronomical achievements are discussed in two brief appendices by HENRY NORRIS RUSSELL of Princeton. The discovery of Pluto is exceedingly strange, far more so than most people realize. Says RUSSELL : " The question arises, if PERCIVAL LOWELL's results were vitiated in this way by errors made by others more than a century before his birth, why is there an actual planet moving in an orbit which is so uncannily like the one he predicted? There seems no escape from the conclusion that this is a matter of chance. That so close a set of chance coincidences should occur is almost incredible, but the evidence assembled by ERNEST W. BROWN permits of no other conclusion. Other equally remarkable coincidences have occurred in scientific experience. A cipher cablegram transmitting to the Lick Observatory the place of a comet discovered in Europe was garbled in transmission, and when decoded gave an erroneous position in the heavens. Close to this position that evening another undiscovered comet was found. More recently a slight discrepancy between determinations of the atomic weight of hydrogen by mass-spectrograph and by chemical means led to a successful search for a heavy isotype of hydrogen. Later and more precise work with the mass-spectrograph showed that the discrepancy had at first been much over-estimated. Had this error not been made, heavy hydrogen might not yet have been discovered." G. S.

Stevenson, A. F. C. SIMON NEWCOMB. His contributions to mathematics and astronomy. *Journal of the Royal astronomical society of Canada* 29, 180-84, 1935. ISIS

C. — *Natural sciences*

Ashworth, J. H. CHARLES DARWIN as a student in Edinburgh, 1825-27. *Nature* 136, 1011-14, 1935. ISIS

Bergson, Henri. The philosophy of CLAUDE BERNARD. *Bulletin of the institute of the history of medicine* 4, 15-21, port., 1936. ISIS

Address delivered at the centenary celebration of CLAUDE BERNARD at the Collège de France, 30 Dec. 1913. Published in " La pensée et le mouvant," by HENRI BERGSON. Paris, ALCAN, 1934. Translated by ARNOLD C. KLEBS, Nyon.

Bernard, Charles J. La botanique coloniale et l'œuvre du Professeur MELCHIOR TREUB. *Revue générale des sciences* 46, 631-37, 664-68, 1935. ISIS

Hingston, Richard William George. DARWIN. 144 p. ;

MACBRIDE, E. W. HUXLEY. 143 p.; MARTIN, THOMAS. FARADAY. 144 p. (Great lives, 27, 34, and 40). London, DUCKWORTH, 1934. ISIS

These convenient, though brief, biographies of great men are summaries of the facts concerning the life and work of each, accompanied by a more or less informal survey of the content of their writings of major significance. In HINGSTON's life of DARWIN these summaries are analytical, specific, and more objective than in the other two biographies. DARWIN's own summary of the *Origin*, quoted on p. 62, is taken from the second edition, although not so stated. The first edition does not contain the words here italicized in the phrase "There is a grandeur in this view of life, with its several powers having been originally breathed *by the Creator* into a few forms, or into one." The biographer emphasizes the experimental aspects of DARWIN's method with many examples.

Professor MACBRIDE makes his biography of HUXLEY a vehicle to expound his own critical attitude toward DARWIN's view of natural selection and to set forth his advocacy of the Lamarckian view of the potency of effort initiated by environmental change leading to habit and thus to evolutionary change.

MARTIN's biography of FARADAY is an objective and analytical presentation of the experimental methods and results achieved by this great physicist and a sympathetic presentation of the man.

These booklets would gain in value by adequate documentation of significant citations. One regrets to see the names of PRIESTLEY and LA METTRIE incorrectly spelled. C. A. K.

Keynes, Geoffrey; **Hill, Brian.** Distribution of SAMUEL BUTLER's manuscripts. *London Times Literary Supplement*, p. 764, November 23, 1935. ISIS

MacBride, E. V. HUXLEY. 143 p. (Great lives, 34). London, DUCKWORTH, 1934. ISIS

See section XIX (2) C, note HINGSTON, R.W.G.

Roger, H. La philosophie de CLAUDE BERNARD. *Les cahiers rationalistes*, no. 45, 259-89, 1935. ISIS

D. — *Medical sciences*

Forel, August. Rückblick auf mein Leben. 295+VII p., 14 fig. Zürich, Europa-Verlag, 1935. ISIS

Menetrier. M. Le Professeur (1859-1935). Obituary by M. LAIGNEL-LAVASTINE, *Bull. de la soc. franç. d'hist. de la méd.* 29, 245-47, 1935. ISIS

Schlueter, Robert E. MOSES LEWIS LINTON, A. M., M. D., L. L. D. (1808-1872). *Bulletin of the academy of science of St. Louis*, 1, 53-54, 1935. ISIS

Sigerist, Henry E. An autograph note of LOUIS PASTEUR. *Bulletin of the institute of the history of medicine* 4, 153-57, 2 fig., 1936. ISIS

Weve, H. J. M.; Doesschate, G. ten. Die Briefe ALBRECHT VON GRAEFE's an F. C. DONDERS (1852-1870), mit Bemerkungen versehen. 103 p. Stuttgart, ENKE, 1935 (M. 2.40 geheftet). ISIS

This is a collection of 67 letters, originally published as a *Beilageheft* to Volume 95 of *Monatsblätter für Augenheilkunde*, sent by ALBRECHT VON GRAEFE to his ophthalmological colleague and personal friend, F. C. DONDERS of Utrecht from 1852 to 1870, a period of great development in ophthalmology. Coming, as they do, from the foremost leader in this development to an eminent colleague they have an autobiographical value and provide a stream of contemporary comment on this important field. The editors have enriched the collection by bibliographical and technical notes. C. A. K.

Winckel, Ch. W. F. De geschiedenis van het geneeskundig tijdschrift voor Nederlandsch-Indië. *Bijdragen tot de geschiedenis der geneeskunde* 16, 1-10, 1936. ISIS

E. — *Alia*

Harris, William Torrey (1835-1909). A collection of essays, including papers and addresses presented in commemoration of Dr. HARRIS' Centennial at the St. Louis meeting of the western division of the American philosophical society. Edited by EDWARD L. SCHAUB. VII+136 p., frontispiece. Chicago, Open Court, 1936. ($1.25). ISIS

This Collection is valuable for the knowledge of HARRIS' personality and the philosophical movement in St. Louis, "the political philosophy of HEGEL in a frontier society," as one of the contributors (HARVEY GATES TOWNSEND) put it. Portrait and elaborate bibliography. G. S.

Pirenne, Henri (1862-1935). Obituary by G. L. VAN ROOSBROECK, *Romanic review* 26, October-December 1935. ISIS

XXth Century

A. — *Mathematics*

Hesse, Germaine André. PAINLEVÉ, grand savant, grand citoyen. 246 p., illus. Paris, CORRÊA, 1933 (12 fr.). ISIS

Panegyric of PAUL PAINLEVÉ (1863-1933), badly composed and very badly written in the worst kind of French journalese. However, the book contains valuable materials: PAINLEVÉ's testimony in the affaire DREYFUS, this involved JACQUES HADAMARD, MAURICE D'OCAGNE and H. POINCARÉ (long letter from him apropos of the Bertillon system, pp. 73-7); PAINLEVÉ's speeches on ANATOLE FRANCE and PASCAL. The author's references to PAINLEVÉ's mathematical work are silly. A very bad book. G. S.

B. — *Physical sciences and technology*

Harbord, James G. World wireless. The engineer's place in radio communication. An address delivered before Princeton University on November 12, 1935, in the Cyrus Fogg Brackett lectureship in applied engineering and technology. 37 p. Guild of Brackett lecturers, 1936. ISIS

Kuwaki, Ayao. ALBERT EINSTEIN. 6+296+20 p., 10 pl. Tokyo, Kaizôsya, 1934 (In Japanese). ISIS

This elegant little volume contains an elaborate biography of EINSTEIN, divided as follows: 1. From childhood to the end of his student-life; 2. After his graduation to the days in Bern; 3. Investigations in Bern days; 4. Influence of his earlier works on contemporary physicists; 5. From 1909 to 1912; 6. The development of the theory of relativity and of gravitation; 7. Call to Berlin. Lecture tours through the world; 8-9. After that time; 10. LORENTZ and EINSTEIN; 11-12. PLANCK and EINSTEIN. EINSTEIN's bibliography (1901-34) is printed in Latin type and hence can be read by everybody. The book is illustrated with many portraits of EINSTEIN, one of LORENTZ and three of PLANCK. The author is a distinguished physicist, professor at the Engineering College of the Kyushu Imperial University, in Fukuoka, and we may depend upon him to give a clear and sound account of EINSTEIN's contributions and of the general tendencies of modern physics. G. SARTON.

Lippmann, Edmund O. von. Fortschritte der Rübenzucker-Industrie 1935. *Chemiker-Zeitung* Nr. 12, 127-29, 1936. ISIS

D. — *Medical sciences*

Diepgen, Paul. LUDWIG ASCHOFF zum 70. Geburtstag am 10. Januar 1936. *Mitt. zur Gesch. d. Med., d. Naturw. u. d. Techn.* 35, 3-4, 1936. ISIS

Schlueter, Robert E. AUGUSTUS VAN LIEW BROKAW. *Surgery, gynecology and obstetrics* 61, 411-13, 1935. ISIS

Schlueter, Robert E. PAUL YOER TUPPER. *Surgery, gynecology and obstetrics* 58, 921-22, 1934. ISIS

E. — *Alia*

Saintyves, P. (EMILE NOURRY), 1870-1935. *Revue anthropologique* 45, nos. 10-12, 1935. ISIS

Numéro consacré à P. SAINTYVES, avec bibliographie de ses travaux (p. 356-9). J. P.

PART II

HISTORICAL CLASSIFICATION

I. — ANTIQUITY

1. — ANTIQUITY
(Generalities)

Bortolotti, Ettore. La scienza algebrica degli Egizi e dei Babilonesi. *Memorie della R. Accademia delle scienze dell'Istituto di Bologna*, 2, 27 p., 1934-35. ISIS

Morey, George W. The mystery of ancient glassware. *Art and archaeology* 28, 199-205, figs., 1929. ISIS

This is a valuable paper because it is written by a technician (a member of the geophysical laboratory of the Carnegie Institution) with full appreciation of the technical problems involved. G. S.

Neugebauer, Otto. Vorlesungen über Geschichte der antiken mathematischen Wissenschaften. Erster Band, Vorgriechische Mathematik. XII+212 p. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen, 43). Berlin, SPRINGER, 1934. ISIS

Reviewed by R. C. ARCHIBALD, *Isis* 24, 151-53, 1935.

Neugebauer, Paul Victor. Spezieller Kanon der Mondfinsternisse für Vorderasien und Aegypten, von 3450 bis 1 vor Chr. 46 p. (Ergänzungshefte zu den Astronomischen Nachrichten, IX, 4). Kiel, 1934. ISIS

Reviewed by D. SIDERSKY, *Revue d'assyriologie et d'archéologie orientale* 33, 63, 1936.

2. — EGYPT

Borchardt, Ludwig. Nachträge zu Nilmesser und Nilstandsmarken. *Sitzungsberichte der preussischen Akademie der Wissenschaften*, phil.-hist. Kl., 11-13, p. 194-202, 1 fig., 3 pl., Berlin, 1934. ISIS

Breasted, James Henry (1865-1935). Obituary by WARREN R. DAWSON, *Journal of the royal asiatic society* 179-84, 1936. ISIS

Grapow, Hermann. Untersuchungen über die altägyptischen medizinischen Papyri. I. Teil. IV+112 p. (*Mitteilungen der vorderasiatisch-aegyptischen Gesellschaft*, 40). Leipzig, HINRICHS, 1935. ISIS

Inhalt: Einleitung; Inhalt und Analyse der Papyri, 1. Pap. med. Kahun, 2. Pap. veter. Kahun, 3. Pap. Edwin Smith, 4. Pap. Ebers, 5. Pap. Hearst, 6. Pap. Berlin 3038, 7. Pap. London; Entstehung der Sammelhandschriften; Orthographisches; Zur Entstehung der Papyri; Arzt und Kranker; Der Arzt; Der Kranke. Reviewed by MAX MEYERHOF, *OLZ* 39, 13-18, 1936 and by A. SCHARFF, *DLZ* 57, 13-14, 1936.

Pogo, Alexander. Three unpublished calendars from Asyut. *Osiris*, vol. 1, 500-09, 10 pl., 1936. ISIS

In a paper which appeared in *Isis* 17, 6-24, 1932, the writer discussed the existence of two types of Asyut calendars—the 24-column and the 36-column type. In the present paper, the origin of these two types is investigated. A discussion of the seasonal changes in the time of rising, culmination, and setting of equatorial stars leads to the construction of two types of diagonal calendars; the use of equinoctial hours of 60 minutes each leads to a diagonal calendar of the 24-column type; the use of decanic hours of 40 minutes each permits us to construct a 36-column diagonal calendar. A composite decanologue of the Middle Kingdom is given, based on eight Asyut calendars. Reproduction of photographs and discussion of three unpublished calendars on coffin lids from Asyut. A. P.

Sethe, Kurt. Zur Geschichte der Einbalsamierung bei den Ägyptern und einiger damit verbundener Bräuche. *Sitzungsberichte der preussischen Akademie der Wissenschaften*, phil.-hist. Kl., 13, 211—39, 16 p., Berlin, 1934. ISIS

3. — BABYLONIA AND ASSYRIA

Drower, E. S. Mandaean writings. *Iraq* 1, 171-82, 14 figs., 1934. ISIS

" It is rarely that an outsider is privileged to see, far less handle, Mandaean books and rolls in Iraq, and the fact that I have been allowed, by degrees, so to do is a proof of the kindness and toleration which my Mandaean friends in Iraq have shown to me. At my request the box is usually opened, the precious manuscripts handed down from father to son are lifted out, the white cloth which wraps them is taken off, and they are opened for me to see. I have even had a Book of Souls written in my name, a compliment which, I am told, has never before been paid to one not a Mandaean." General description of the holy books and of the rituals pertaining to them. Account of magic rolls, and of Diwans, or large illustrated rolls, etc. G. S.

Fotheringham, J. K. Two Babylonian eclipses. *Monthly notices of the Royal astronomical society* 95, 719-23, 1935. ISIS

" With two exceptions the recorded times of ancient eclipse observations are provokingly vague. Otherwise the time is only once expressed more definitely than to the nearest third of an hour; the interval separating the observation from sunset, from which the original measure of time was normally made, is often long, and the observed time may therefore be affected by a large clock-error; and if this interval is long there is room for the additional error arising from the conversion of time from one system of reckoning to another. What is wanted is an eclipse observed close to sunset, and with the interval separating the observation from sunset expressed in small units of time. Only two such eclipses are known to me. But two accurately timed observations may be of more value than a long series of vaguely timed observations." These two eclipses are the eclipse of the sun, — 321 Sept. 26 and the eclipse of the moon, — 424 October 9. G. S.

Miller, G. A. On the history of negative numbers. *Science* 82, 517, 1935. ISIS

Neugebauer, Otto. Mathematische Keilschrift-Texte, I. Teil, 516 p.; II, Teil, 64 p., 69 pl. (*Quellen und Studien zur Geschichte der Mathematik, Astronomie u. Physik*, Abt. A, 3). Berlin, SPRINGER, 1935. ISIS

Very important review by F. THUREAU-DANGIN, *Revue d'assyriologie et d'archéologie orientale* 33, 55-61, 1936.

Thureau-Dangin, F. L'équation du deuxième degré dans la mathématique babylonienne, d'après une tablette inédite du British Museum. *Revue d'assyriologie et d'archéologie orientale* 33, 27-48, 1936. ISIS

A propos de la tablette nº 13901 qui " remonte certainement au temps de la première dynastie babylonienne. Elle peut dater des environs de l'an 2000. C'est, avec le Prisme du Louvre AO 8862, l'un des plus anciens textes mathématiques babyloniens qui nous soient parvenus. Divisée en deux colonnes, elle est inscrite sur chaque face et mesure douze centimètres

de largeur et un peu moins de vingt centimètres de hauteur. Elle est fortement endommagée. Intacte, elle devait comprendre vingt-quatre problèmes : sur ce nombre, vingt sont ou complets ou reconstituables. Ces problèmes ont pour objet la résolution de l'équation du deuxième degré. Parmi les exemples proposés, se trouvent des systèmes d'équations à deux, trois ou quatre inconnues (nos VIII à XV, XVII à XIX et XXIV). L'un de ces systèmes donne lieu à une équation bicarrée (no XII). Telle qu'elle est énoncée dans notre texte, l'équation complète du deuxième degré additionne, comme dans le texte du Louvre, une ' surface ' et une ' longueur,' ou retranche une ' longueur ' d'une ' surface.' Ainsi le premier problème est formulé comme il suit : ' J'ai additionné la surface et (le coté de) mon carré : c'est (tant).' Ce que le scribe appelle ' surface du carré ' est ce que nous désignons par x^2 et ce qu'il appelle ' coté du carré ' est ce que nous désignons par x. Sa conception de l'équation est à peine moins abstraite que la nôtre, bien qu'elle soit exprimée en termes géométriques. L'équation $ax^2 + bx = c$ est, dans notre texte, généralement résolue par la formule

$$x = \frac{-\,30'b \pm \sqrt{[30'b]^2 + ac}}{a}$$

... " Notons que le scribe ne s'oblige aucunement à appliquer cette formule dans tous les cas. Quand il y trouve avantage, il procède autrement, témoin, on le verra, le no XXIII. Il se contente dans chaque cas de décrire les opérations à faire, sans jamais donner ses raisons, sans jamais ' démontrer.' Il nous incombe donc de reconstituer cette démonstration absente. C'est ce que j'ai essayé de faire dans les pages qui suivent. Comme dans le Prisme du Louvre, la graphie phonétique prévaut dans notre texte. Certaines formules sont, en apparence, écrites idéographiquement. Mais je crois que ces formules, qui sont empruntées à des tables, sont en réalité à lire en sumérien. Notre texte est remarquable par sa concision. Il offre, notamment, la particularité de n'écrire qu'une fois le nombre qui, d'une part, exprime le résultat d'une opération et qui, d'autre part, figure dans l'opération immédiatement suivante." G. S.

Vetter, Quido. Quatre notes sur les mathématiques babyloniennes. *Osiris* 1, 692-702, 7 fig., 1936. ISIS

Vogel, Kurt. Bemerkungen zu den quadratischen Gleichungen der babylonischen Mathematik. *Osiris* 1, 703-717, 5 fig., 1936. ISIS

4. — GREECE

Bidez, Joseph. Les écoles chaldéennes sous ALEXANDRE et les Séleucides. *Annuaire de l'Institut de philologie et d'histoire orientales* 3, 41-89, 1935. ISIS

" Jusqu'au temps de PLATON, les communications que l'art, la guerre ou le commerce avaient créées entre la Grèce et la Babylonie ne furent pas assez directes pour amener une pénétration réciproque. Mais les relations

des deux pays se transformèrent après l'expédition d'un conquérant dont ARISTOTE avait formé l'esprit. Dès lors, c'est une véritable fusion des idées qui se prépare, ou plutôt, c'est la civilisation grecque tout entière qui s'installe dans l'Asie et tente de s'y acclimater. L'Orient, d'autre part, depuis l'effondrement de la monarchie perse, devint aussi disposé à subir des influences qu'à en exercer."

Guérin, Pierre. L'idée de justice dans la conception de l'univers chez les premiers philosophes grecs. De THALÈS à HÉRACLITE. 118 p. Paris, ALCAN, 1934. ISIS

Kober, Alice E. The use of color terms in the Greek poets. IV+122 p. New York, Mumphrey Press, 1933. ISIS

Temkin, Owsei. Epilepsy in an anonymous Greek work on acute and chronic diseases. *Bulletin of the institute of the history of medicine* 4, 137-44, 1936. ISIS

Apropos of the *Anonymous parisinus* of which ROBERT FUCHS published extensive parts (1894-1903). G. S.

5. — ROME

Grenier, Albert. Manuel d'archéologie gallo-romaine. Deuxième partie : L'archéologie du sol. 1095 p., 368 fig., 5 pl. (JOSEPH DÉCHELETTE, *Manuel d'archéologie préhistorique, celtique et gallo-romaine*, 6). Paris, PICARD, 1934. ISIS

II. — MIDDLE AGES

6. — MIDDLE AGES
(*Generalities*)

Baxter, J. H.; Johnson, Charles. Medieval Latin word-list from British and Irish sources. Under the direction of a committee appointed by the British Academy. XIII+466 p. Oxford University Press, 1934. ISIS

Reviewed by MARY CATHERINE WELBORN, *Isis* 24, 153-55, 1935.

Crosby, Ruth. Oral delivery in the Middle Ages. *Speculum* 11, 88-110, 1936. ISIS

" In the Middle Ages the masses of the people read by means of the ear rather than the eye, by hearing others read or recite rather than by reading

to themselves. It is the purpose of this article, first, to point out some evidences of the custom of oral delivery in the Middle Ages and, second, to analyze the peculiar characteristics of narratives intended for publication by that means, all with a view to considering in a later article the influence of such a custom on GEOFFREY CHAUCER."

Karst, J. Littérature géorgienne chrétienne. 177 p. (Bibliothèque catholique des sciences religieuses). Paris, BLOUD & GAY, (1934). ISIS

Cette étude est fort précieuse en dépit de sa brièveté. L'auteur nous donne aussi quelques renseignements sur la littérature profane. "La littérature ancienne géorgienne est de caractère essentiellement ecclésiastique. Cette littérature théologique-religieuse, représentée par les ministres de l'Église, surtout le clergé régulier, s'étend du V^e^ au XII^e^ siècles. Durant cette longue suite de siècles, elle se meut en progression lente, et ascendante, d'abord sous l'influence arménienne et syriaque, puis exclusivement sous l'influence de l'église gréco-byzantine, pour atteindre son apogée aux XI^e^ et XII^e^ siècles. Alors fleurit la culture religieuse-monastique (Couvent ibéro-géorgien de l'Iviron sur le mont Athos), laquelle coincïde singulièrement avec le siècle de la reine THAMAR; c'est l'âge d'or de la littérature profane ou nationale géorgienne proprement dite. La littérature sacrée des Géorgiens s'est donc développée dans le sens inverse de la littérature ecclésiastique arménienne. ' l'âge d'or ' de celle-ci s'étend sur le V^e^ siècle, tandis que la floraison chez les Géorgiens apparaît tardivement, juste assez tôt pour servir de stade de préparation, de point de départ, à la poésie laïque chevaleresque du XII^e^ siècle." (p. 13). L'histoire de la littérature géorgienne est continuée jusqu'à nos jours. Bon index et un petit glossaire; il eut été utile d'ajouter une carte. G. S.

Lippmann, Edmund O. von. Honig als Zuckersatz im frühen deutschen Mittelalter. *Die Deutsche Zuckerindustrie* Nr. 26, p. 598, 1935. ISIS

Thompson, Daniel V., jr. De coloribus, naturalia exscripta et collecta, from Erfurt, Stadtbücherei, MS. Amplonius quarto 189 (XIII-XIV century). *Technical studies* 3, 133-45, 1935. ISIS

Thompson, Daniel V., jr. Medieval parchment making. *Transactions of the Bibliographical Society*, 113-17, Oxford, 1935. ISIS

Ulich, Robert. Vagantenlieder aus der lateinischen Dichtung des 12. und 13. Jahrhunderts. Carmina burana. Übertragen und eingeleitet von ROBERT ULICH. Den lateinischen Text bearbeitete MAX MANITIUS. VIII+175 p., 8 pl. Jena, DIEDERICH, 1927. ISIS

A fine collection of those *carmina burana* which the wandering students sang (*Introd.* 2, 320), edited with German translations and a modicum of

notes. Beautifully printed—the German in Gothic type—with appropriate illustrations. G. S.

Van de Vyver, A. Les plus anciennes traductions latines médiévales (X^e^-XI^e^ siècles) des traités d'astronomie et d'astrologie. *Osiris* 1, 658-91, 1936. ISIS

Contents: 1. Les traités d'astrologie d'ALCHANDREUS et d'ALEXANDRE; 2. L'astronomie de NEMROD; 3. Praeceptum canonis PTOLEMAEI; 4. Une compilation d'astronomie s. XI-XII en 4 livres.

III. — ORIENTAL SCIENCE AND CIVILIZATION

8. — ASIA
(Generalities)

WESTERN ASIA

Johnson, Jotham. Observation of the equinox at Petra. *Journal of the American Oriental Society* 55, 464-65, 1935. ISIS

CENTRAL ASIA

Andreas, F. C. Mitteliranische Manichaica aus Chinesisch-Turkestan. III. Aus dem Nachlass herausgegeben von W. HENNING. *Sitzungsberichte der preussischen Akademie der Wissenschaften*, phil.-hist. Klasse, 27, 848-912, 1934. ISIS

Hackin, J. Répartition des monnaies anciennes en Afghanistan. *Journal asiatique* 226, 287-92, map., 1935 (received Feb. 1936). ISIS

EASTERN ASIA

(Including works relative to the whole of Buddhist Asia, or to India, Central and Eastern Asia combined)

Ellis, A. G. The service to medicine in Siam rendered by His Royal Highness Prince MAHIDOL of Songkla, C. P. H., M. D. (Harvard). *Bulletin of the institute of the history of medicine* 4, 165-98, 1936. ISIS

The story refers to the years 1920 to 1929. Prince MAHIDOL died on Sept. 24, 1929. G. S.

Rutten, L. M. R. (editor). Science in the Netherlands East Indies. VIII+432 p. (Koninklijke Akademie van Wetenschappen, Amsterdam, DE BUSSY (1929). ISIS

This undated volume was published by the Dutch Academy of sciences on the occasion of the Fourth Pacific Science Congress which met at Batavia and Bandong in 1929. It is very different from the volume published in Tokyo 1926 apropos of the Third Pacific Science Congress; the Japanese volume was entitled "Scientific Japan, past and present" (*Isis* 10, 83-8). The Dutch volume deals with the present rather than the past; it is an elaborate geographical, geophysical, and biological description of the Dutch Indian empire, and of its scientific activities. However, there is a chapter on archaeology by N. J. KROM, and there are historical notes here and there. G. S.

9. — INDIA

Brunn, Prof. V. Von einer bisher unbekannten früh-indischen Kultur. *Sudhoffs Archiv für Geschichte der Medizin* 28, 347-58, 1935. ISIS

Apropos of Mohenjo-daro.

Burgess, Ebenezer (1805-70). Translation of the Sūryasiddhānta. A text-book of Hindu astronomy. With notes and an appendix. Reprinted from the edition of 1860. Edited by PHANINDRALAL GANGOOLY. With an introduction by PRABODHCHANDRA SENGUPTA. LI+409 p., figs., 1 map., University of Calcutta, 1935. ISIS

This handsome reprint of a classical work first printed in the *Journal of the American Oriental Society* in 1860 is very welcome. It is preceded by a summary of Hindu astronomy (44 p.) by Professor SENGUPTA of Calcutta University. That introduction "attempts at tracing the growth and development of the Sūrya Siddhānta as to its date, authorship and methods according to the most recent researches of its writer; it also aims at showing the independence of the Hindu scientific astronomy of any foreign, more specially the Greek, source." The editor has added a note on the calculation of eclipses (12 p. inserted between pp. 392 and 393). Elaborate Sanskrit and English indices. The Rev. E. BURGESS was born at Grafton, Vermont, U. S. A., 1805; he studied in Amherst College and Andover Theological Seminary and for a time taught Hebrew and Greek at the Union Theological Seminary; in 1839 he went to India as a missionary to the Marathas; he lived in the Bombay Presidency for fifteen years then returned to U. S. A.; he died at Newton Centre, Mass., 1870. He was truly a pioneer of Hindu science. There is no biography of him in *DAB*! It is said by Dr. GANGOOLY that he wrote a history of Hindu astronomy which remained unpublished. Where is the MS of it, I wonder? G. S.

Charpentier, Jarl. (1884-1935) The Livro da seita dos Indios orientais

(Brit. Mus. MS Sloane 1820) of Father JACOBO FENICIO, S. J. Edited with an introduction and notes. CIV+252 p. (Arbeten utgivna med understöd av Vilhelm Ekmans universitetsfond, Uppsala, 40). Uppsala, ALMQVIST & WIKSELLS, 1933. ISIS

In 1922, with the help of Father SCHURHAMMER, CHARPENTIER was able to ascribe this early Portuguese account of Hindu religion to JACOBO FENICIO (or FINICIO). Father FENICIO was born at Capua, c. 1558, entered the Society of Jesus in 1580, arrived in India in 1584—and remained there until his death at Cochin in 1632. He used to preach in the Malayālam language. He wrote his account in 1609. The late CHARPENTIER gives us a critical edition of the Portuguese text with a wealth of notes (unfortunately printed at the end of the volume), and an elaborate introduction retracing the history of the Western knowledge of India from Greek times until the seventeenth century. This includes a long account of the Jesuit efforts which increased materially our knowledge of India and of the Hindus. I noticed with special interest that the English Jesuit THOMAS STEPHENS 1549?-1619) in a letter dated 1583 " pointed to the similarity of structure between the Indian languages and those of the old world, Greek and Latin. It seems obvious, that two Englishmen, THOMAS STEPHENS and Sir WILLIAM JONES, first of all formed some idea of the connection between Indian and European languages." (p. lv). Obituary of the author by E. J. RAPSON (J. R. A. S., 177-79, 1936). G. S.

Coomaraswamy, A. K. L'idée de création éternelle dans le *Rig Véda*. *Etudes traditionelles*, 41e année, no. 193, 13-17, 1936. ISIS

Eliade, Mircea. Elemente pre-Ariene in Hinduism. *Revista Fundaţilor Regale* 1, 27 p., 1936. ISIS

Guénon, René. Sacred and profane science. Translated from the French by ANANDA K. COOMARASWAMY. *The Visva-Bharati quarterly*, 11-24, NOV. 1935. ISIS

" From *La crise du monde moderne*, Paris, 1927. The translator holds that no living writer in modern Europe is more significant than RENÉ GUÉNON, whose task it has been to expound the universal metaphysical tradition that has been the essential foundation of every past culture, and which represents the indispensible basis for any civilisation deserving to be so called. In GUÉNON's view (shared by the translator) Europe has diverged from this path ever farther and farther since the thirteenth century; only since that time have Europe and Asia been truly divided in spirit. The true contrast is then not so much between Europe and Asia as such, as between Mediaeval Europe and Asia on the one hand, and the modern world on the other. Europe and Asia can meet, and can only meet in complete accord, upon the common ground of the metaphysical and purely intellectual tradition, upon the basis of what is called in our terms *sanātana dharma*, though it is by no means to be understood that this ' wisdom

uncreate, the same now as it ever was, and the same to be for evermore' (St. AUGUSTINE) belongs to the Indian, European, or any other part of humanity exclusively."

Müller, Reinhold F. G. Zu altindischen Anschauungen von den Eingeweiden des Leibes. *Sudhoffs Archiv für Geschichte der Medizin* 28, 229-63, 5 fig., 1935. ISIS

Singh, A. N. On the use of series in Hindu mathematics. *Osiris* 1, 606-28, 1936. ISIS

"The object of the present paper is to give an account of the use of series in Hindu mathematics. For this purpose the Hindu literature, mathematical as well as non-mathematical, has been examined. Particular instances of the arithmetic and geometric series have been found to occur in Vedic literature as early as 2000 B. C. From Jaina literature it appears that the Hindus were in possession of the formulae for the sum of the arithmetic and the geometric series as early as the fourth century B. C., or earlier."

Uvanović, Daniel. The Indian prelude to European mathematics. *Osiris*, 1, 652-57, 1936. ISIS

10. — CHINA

Boyer, Auguste M.; Rapson, Edward James; Senart, Emile C. M. Kharoṣṭhī inscriptions discovered by Sir AUREL STEIN in Chinese Turkestan. Part 1 : Text of inscriptions discovered at the Niya Site, 1901. Transcribed and edited by A. M. BOYER, E. J. RAPSON, and E. SENART. IV+154 p., VI pl. 1920. Part 2 : Text of inscriptions discovered at the Niya, Endere, and Lou-lan sites, 1906-7. Transcribed and edited by the same. II+p. 155-266, pl. VII—XII. 1927. Part 3 : Text of inscriptions discovered at the Niya and Lou-lan sites, 1913-14. Transcribed and edited by E. J. RAPSON and P. S. NOBLE. With complete *index verborum*. VIII+p. 267—380, pl. XIII—XIV. Oxford, Clarendon Press, 1920-29. ISIS

Reviewed by G. L. M. CLAUSON, *Journal of the Royal Asiatic Society*, 203-04, 1930.

Chinese Medical Monthly. Official organ of the medical profession in China, The Chinese Medical Association. Parasitology number, Professor FÜLLEBORN memorial. November-December, vol. 47, nos. 11 and 12, Peiping, China, 1933. ISIS

This number of the Chinese medical monthly consists of twenty-nine original articles on parasitology, and is dedicated to the memory of Professor FRIEDRICH FÜLLEBORN (1866-1933), late Director of the Institute for Tropical Diseases at Hamburg.

Reviewed in *Annals of medical history* 6, 379, 1934.

Conrady, Auguste (1864-1925). Yih-king-Studien. Herausgegeben von EDUARD ERKES. *Asia major* 7, 409-68, 1931. ISIS

Notes on the *I-ching* (*Book of Changes*). G. S.

Cressey, George Babcock. China's geographic foundations : a survey of the land and its people. XVII+436 p., 1 map. New York, MCGRAW-HILL, 1934. ISIS

Reviewed by E. E., *Bulletin of the School of Oriental Studies* 7, 643-45, 1934 and in *Nature* 136, 533, 1935.

Devine, W. The four churches of Peking. 225 p. London, BURNS, OATES, 1930. ISIS

Doré, Henri (S. J.). Recherches sur les superstitions en Chine. III[e] partie, t. XV, Vie illustrée du Bouddha Cakyamouni. XI+394 p., 45 pl. (*Variétés sinologiques*, no. 57). Chang-hai, Imprimerie de la Mission Catholique, 1929. ISIS

Reviewed by P. MUS, *BEFEO*, 29, 436-38, 1929.

Duyvendak, Jan Julius Lodewijk. The book of Lord SHANG. A classic of the Chinese school of law, translated from Chinese with introduction and notes. (*Probsthain oriental series*, 17). London, 1928. ISIS

Reviewed by H. MASPERO, *Journal asiatique* 222, 48-59, 1933 (received March 1934).

Eberhard, Wolfram. Beiträge zur kosmologischen Spekulation der Chinesen der Han-Zeit. 102 p. (Baessler-Archiv, 16). Berlin, 1933. ISIS

Eberhard, Wolfram. Zur frühchinesischen Astronomie. *Forsch. u. Fortschr.* 9, 252-53, 1933. ISIS

Forke, Alfred. Geschichte der mittelalterlichen chinesischen Philosophie, XII+410 p. (*Hamburgische Universität Abhandl. aus dem Gebiet der Auslandskunde* 41, Reihe B : Völkerskunde, Kulturgeschichte u. Sprachen, 21). Hamburg, Friederichsen, DE GRUYTER, 1934. ISIS

Franke, Otto. Grundsätzliches zur Wiedergabe fremder Länder- und Ortsnamen im Chinesischen. *Sitzungsberichte der preussischen Aka-*

demie der Wissenschaften, phil.-hist. Kl., 14 & 15, 244-80, Berlin, 1934. ISIS

Franke, Otto. Zur Beurteilung des chinesischen Lebenswesens. *Sitzb. der preuss. Akad.* phil.-hist. Kl. 359-77, fig., 1927. ISIS

"Tatsächlich gehört der Lehensgedanke zur Weltanschauung der Chinesen, er ist unlöslich verflochten mit den Vorstellungen von Weltstaat und Universalmonarchie. Der oberste Reichsherrscher selbst ist ja nichts anderes als ein Lehensfürst des Himmels."

Gale, Esson McDowell. Discourses on salt and iron. A debate on state control of commerce and industry in ancient China, chap. I-XIX, translated from the Chinese of HUAN K'UAN with introduction and notes (*Sinica leydensia*, II). LVI+165 p. Leyde, 1931. ISIS

Reviewed by HENRI MASPERO, *Journal asiatique* 226, 173-76, 1935.

Galt, Howard Spilman. The development of Chinese educational theory. VII+180 p. Shanghai, Commercial Press, 1929. ISIS

Gamble, Sidney David. How Chinese families live in Peiping; a study of the income and expenditure of 283 Chinese families receiving from $8 to $500 silver per month. XII+348 p., 38 illus. London, FUNK and WAGNALLS, 1933. ISIS

Reviewed by DOROTHEA HOSIE, *Journal of the royal Asiatic society*, 599-600, 1934.

Gardner, Charles S. Chinese studies in America. A survey of resources and facilities. I. Eastern Canada and New England. VIII+87 p. Washington, D.C., American Council of Learned Societies, 1935 (mimeographed, 50 cts.). ISIS

These notes prepared by C. S. GARDNER and J. D. HATCH were finally edited by MORTIMER GRAVES. They give one a very high idea of the resources available in this part of the world to the Sinologist, and should stimulate his efforts. G. S.

Gervais, Albert. Medicine man in China. Translated by VINCENT SHEEAN. 336 p. New York, STOKES, 1934. ISIS

Giles, Herbert Allen; Waley, Arthur. Select Chinese verses. Translated. I+XI+p. 3—96. Shanghai, Commercial Press, 1934. ISIS

Reviewed by A. C. MOULE, *Journal of the Royal Asiatic society*, 761, 1935.

Gotô, Sueo. Introduction des idées chinoises en France au XVII^e^ et au XVIII^e^ siècle. Tokyo Imperial University, 1928. ISIS

Reviewed in *Report of the Librarian of Congress* 211, 1935.

Hackmann, Heinrich. Die dreihundert Mönchsgebote des chinesischen Taoismus. 84 p. (Verhandelingen d. Koninkl. Akad. v. Wetenschappen te Amsterdam. Afdeeling Letterkunde, nieuwe reeks, deel 32). Amsterdam, 1931. ISIS

Hackmann, Heinrich. Ein chinesisches Urteil über den Taoismus von Lung Hu shan und Shang Ch'ing. *Acta orientalia*, 7, 293-304, 1929. ISIS

Harada, Yoshito. Lo-Lang : a report on the excavation of the WANG Hsü's tomb in the ancient Chinese colony in Korea. With the collaboration of KINGO TAZAWA : with appendix, On human bones, teeth and hair found in WANG Hsü's tomb, by K. KIYONO, etc. 148 p., 128 pl. Tokyo, Tokoshoin, 1930 (Texts in English and Japanese). ISIS

Reviewed by SHIO SAKANISHI, *Journal of the American Oriental Society* 54, 97-9, 1934.

Harvey, Edwin Deeks. The mind of China. x+321 p. New Haven, Yale University Press, 1933. ISIS

Reviewed by ARTHUR W. HUMMEL, *American historical review* 39, 575, 1934; and by E. E., *Bull. of the school of oriental studies* 7, 643-45, 1934.

Hashimoto, Masukichi. A study of the calendar of the Ch'un-ch'iu. *Shikagu Zasshi* 45, 415-41, 585-628, 1934 (in Japanese). ISIS

Abstracted by EDWIN C. REISCHAUER, Abstracts of articles appearing in current Japanese periodicals, pp. 14-17, American Council of Learned Societies, 1935. See *Isis* 24, 259.

Hedin, Sven. Jehol. Die Kaiserstadt. Mit 78 Abbildungen nach Handzeichnungen des Verfassers und photographischen Aufnahmen von GOESTA MONTELL. 212 p. Leipzig, BROCKHAUS, 1932. ISIS

Reviewed by T. C. HODSON, *Journal of the Royal Asiatic society*, 208, 1933.

Hedin, Sven. Jehol, city of emperors. Translated from the Swedish by E. J. NASH. xiv+278 p., 65 ills., map. London, KEGAN PAUL 1932. ISIS

Reviewed by T. C. HODSON, *Journal of the Royal Asiatic society*, 480-82; and in *Nature* 131, 184-85, 1933.

Hooper, David. On Chinese medicine : drugs of Chinese pharmacies in Malaya. The Gardens Bulletin, Straits Settlements, vol. 6, part 1. December 1929. ISIS

Reviewed by T. A. H., *Nature* 125, 862-64, 1930.

Hopkins, L. C. The Cas-chrom v. the Lei-ssŭ. A study of the primitive forms of plough in Scotland and ancient China. *Journal of the Royal Asiatic society*, 45-54, pl., 5 fig., 1936. ISIS

Hsü, Leonard Shihlien. The political philosophy of Confucianism. An interpretation of the social and political ideas of CONFUCIUS, his forerunners, and his early disciples. XXII+258 p. (Broadway Oriental library). London, ROUTLEDGE, 1932. ISIS

Hsu, Sung-nien. Anthologie de la littérature chinoise des origines à nos jours. La poésie. — Le roman. — Le théâtre. — La philosophie. — L'histoire. 445 p. Paris DELAGRAVE, 1933. ISIS

Reviewed by LIONEL GILES, *Journal of the Royal Asiatic Society*, 815-17, 1934.

Hu Shih. The Chinese renaissance. XI+110 p. Chicago, University Press, 1934. ISIS

Reviewed in *Journal of the American Oriental society* 55, 223, 1935.

Hummel, Arthur W. The autobiography of a Chinese historian, being a preface to a symposium on ancient Chinese history (*Ku shih pien*), translated and annotated. XLII+199 p., 1 facs. (*Sinica Leidensia*, 1). Leyden, BRILL, 1931. ISIS

Reviewed by P. PELLIOT, *T'oung Pao*, 29, 130-35, 1932.

Hung, William. Indexing Chinese books. A paper read at a meeting of the Chinese political and social science association, December 12, 1930. 13 p., 2 pl. (1930). ISIS

Reviewed in *T'oung Pao*, 28, 497-501, 1931.

Jacob, Georg ; Jensen, Hans. Das chinesische Schattentheater. XV+130 p. (*Das Orientalische Schattentheater*, 3). Stuttgart, KOHLHAMMER, 1933. ISIS

Johnston, Reginald Fleming. Confucianism and modern China. (Lewis Fry memorial lectures, 1933-34). 272 p., 8 pl. London, GOLLANCZ, 1934. ISIS

Johnston, Reginald Fleming. Twilight in the forbidden city. Preface by the Emperor. 486 p., 36 ills. London, GOLLANCZ, 1934. ISIS

Reviewed by DOROTHEA HOSIE, *Journal of the Royal Asiatic society*, 420-24, 1935.

Kao, Kiun. Conversion des dates chinoises en jours de la période julienne. Academia Sinica. XVI+VIII+173 p. (National research institute of astronomy, monographs no. 1). Nanking, 1932. ISIS

Karlgren, Bernhard. Some fecundity symbols in ancient China. *Bulletin of the Museum of Far-Eastern antiquities*, no. 2, Stockholm, 1930. ISIS

Reviewed by HENRI MASPERO, *Journal asiatique* 222, 18-21, 1933 received March 1934).

Kimura, K. Important works in the study of Chinese medicine. (Bulletin of the naturalists club of Shanghai, no. 3). *China journal* 13, 109-19, Shanghai, 1935. ISIS

Contents: 1. Importance of the determination of the origins of drugs; 2. Pharmacognosy and pharmacognostical study of Chinese medicine; 3. A brief history of Chinese medicine and its important works; 4. Studies on Pên ts'ao in Japan; 5. Scientific works about the origin of Chinese medicines; 6. Conclusion.

"The study of Chinese medicine is now being actively prosecuted in Japan, and many chemists are engaged in the work of determining the chemical composition of these compounds and mixtures. However, only a few specialists, such as Professor N. FUJITA in the Tokyo Imperial University, T. MUNESADA in the Kumamoto Pharmaceutical College, and myself in the Shanghai Science Institute, are engaged in the pharmacognostical study of Chinese medicine. That study presents a very difficult problem because the origins of Chinese products are not clear. Chemistry is making great progress in the world over, yet very few of the Chinese medicines have been chemically identified."... G. S.

Köhler, Günther. Der Hwang-Ho: eine Physio-Geographie. 104 p., 1 map. Gotha, PERTHES, 1929. ISIS

Latourette, Kenneth Scott. The Chinese: their history and culture. 2nd edition. Vol. I, 506 p.; vol. II, 389 p., map. London, MACMILLAN, 1934. ISIS

Reviewed by J. H. PRATT, *Journal of the Royal Asiatic society*, 104-06, 1936; by E. E., *Bull. of the school of oriental studies* 7, 639-41, 1934; and by M. S. BATES, *American historical review* 39, 709-11, 1934.

Lattimore, Owen. Chinese Turkistan. *The Open court*, 47, 97-119, 4 ills., map, 1933. ISIS

Laufer, Berthold. Chinese-Hebrew manuscript, a new source for the history of the Chinese Jews. *American journal of Semitic languages and literatures* 46, 189-97, 1930. ISIS

Reviewed by A. C. MOULE, *T'oung Pao* 28, 125-28 and by P. PELLIOT, ibidem, 176, 1931.

Lo Tchen-ying, Mlle. Les formes et les méthodes historiques en Chine. Une famille d'historiens et son œuvre. 117 p. (*Univ. de Lyon. Bibliotheca Franco-Sinica Lugdunensis*, 9). Paris, GEUTHNER, 1931. ISIS

March, Benjamin (d. 1934). Some technical terms of Chinese painting. XIII+55 p., 7 pl. Baltimore, Waverly Press, 1935 ($1.50). ISIS

"The basis of the list of technical terms here presented was prepared in Peiping during the summer of 1931, incidental to research in a critical problem of Chinese painting pursued with the assistance of a grant in aid of research from the American Council of Learned Societies and a special research fund contributed by members of the Detroit Museum of Art Founders Society. Mr. LIN YÜ-TS'ANG, a painter, and, equally important for the purpose of this study, a student of the classical tradition, worked with me in the compilation and interpretation. The illustrations of type forms and brush strokes, except those of *miao* on plates VI and VII which are taken from the *Tien Shih Chai ts'ung hua*, were drawn by him. The explanations are based also upon a year's experience in the practice of Chinese painting under his tutelage in 1926 and 1927." ... "Landscape is the alpha and omega of Chinese painting. It is the first subject of the novice, and the ultimate accomplishment of the greatest master. Hence it is deserving of the most particular consideration. Of unusual interest to the Occidental student, and most in need of more extended examination, will probably be those features called here 'type forms.' One does not learn to paint by going out and superficially copying the appearance of nature, any more than one becomes a musician by learning to whistle bird calls. As the music student learns his keys and key relationships, the painter learns his type forms; and each uses what he has learned according to well established principles of harmony and composition. Now what are these type forms? They are the evidences of essential reality distilled through centuries of observation of transient effects. Chinese painters were at the same time, often primarily, literati, men of culture and learning, poets. They were men whose habits of observation and of visual memory

and analysis were quickened by their discipline in the writing and reading of the Chinese characters. They were studio painters, without suffering the divorce from nature that such a description often implies in the West. As artists they painted for themselves and for men of their stamp. They were at once the molders and the conservators of taste; they were the producers and the critics. So we might expect their paintings to show to an extraordinary degree the results of conscious analysis and synthesis." For further information on this very valuable study, see my review of SHIO SAKANISHI's new translation of *Kuo Hsi* (*Isis* 25, 461). G. S.

Mori, Osamu ; Naito, Hiroshi. Ying-ch'êng-tzŭ : the Han brick tomb with fresco-painting, etc., near Chien-mu-ch'êng-i, S. Manchuria. With an English résumé by KOSAKU HAMADA. 8 p. (English), 36 §§ in Japanese, 45 pl., 38 fig. Tokyo, Far Eastern Society, 1934. ISIS

Reviewed in *Antiquity* 9, 379, 1935.

Morse, William Reginald. Chinese medicine. 16 illus. (*Clio medica* XI). New York, HOEBER, 1934. ISIS

Reviewed in *Annals of medical history* 6, 289, 1934.

Nagel, Paul. Umrechnung der zyklischen Daten des chinesischen Kalenders in europäische Daten. *Mitt. Seminar Oriental. Sprachen* 34, Abt. 1, 153-60, Berlin, 1931. ISIS

Nakao, Manzo. Notes on Shao-hsing Hsiao-ting Ching-shih Chêng-lei Pei-chi Pên-tsao (The ancient Chinese materia medica. Revised in the Sung Dynasty Shao-hsing period, 1131-1162). *J. Shanghai Sci. Inst.*, 3, 1, 1-9, May 1933. ISIS

Reviewed in *Nature* 133, 792, 1934.

Noda, Chûryô. Chou pi suan ching no kenkyû (An inquiry concerning the Chou pi suan ching). 183 p. Kyoto, Academy of Oriental Culture, 1933 (In Japanese). ISIS

Reviewed by SHIO SAKANISHI, *Isis* 24, 157, 1935.

Palmgren, Nils. Kansu mortuary urns of the Pan Shan and Ma Ch'ang groups. 204 p., 41 pl. (*Palaeontologia sinica*, series D, III, fasc. 1). Peiping, 1934. ISIS

Reviewed by V. G. CHILDE, *Antiquity* 9, 374-76, 1935.

Peake, Cyrus Henderson. The origin and development of printing

in China in the light of recent research. *Gutenberg-Jahrb.* 10, 9-17, 1935. ISIS

Peake, Cyrus Henderson. Nationalism and education in modern China. XIV+240 p. New York, Columbia University Press, 1932. ISIS

Reviewed by K. S. LATOURETTE, *American historical review* 38, 598, 1933

Read, Bernard Emms. Dragon and snake drugs. 66 p., 6 pl. (Chinese materia medica, 7). *Peking Natural history bulletin*, 1932. ISIS

Read, Bernard Emms. Animal drugs. (Chinese materia medica). *Peking Natural history bulletin* 5, 37-80; 6, 1-102, 1931. ISIS

Reviewed by T. A. H., *Nature* 129, 444, 1932.

Rotours, Robert des. Le traité des examens, traduit de la *Nouvelle histoire des T'ang* (chap. XLIV, XLV). VIII+416 p. (Bibliothèque de l'Institut des Hautes études chinoises, 2). Paris, 1932. ISIS

Reviewed by H. MASPERO, *Journal asiatique* 222, 33-7, 1933 (received March 1934).

Sirén, Osvald. Histoire des arts anciens de la Chine. 6 vols. I. La période préhistorique. L'époque Tcheou. L'époque Tch'ou et Ts'in. II. Les arts décoratifs du début de l'époque Han à la fin des six dynasties. III. La sculpture chinoise de l'époque Han à l'époque Ming. IV. L'architecture chinoise de l'époque Han à l'époque Ts'ing. V. Les arts décoratifs des époques T'ang et Song. VI. La peinture chinoise de l'époque Han à l'époque Ts'ing (*Annales du Musée Guimet, Bibliothèque d'art* — nouvelle série, III). Paris, VAN OEST, 1932. ISIS

Smith, David Eugene. Unsettled questions concerning the mathematics of China. *Scientific monthly* 33, 244-50, 1931. ISIS

Suski, Peter Marie. The year names of China and Japan. 40 p. London, KEGAN PAUL, 1931. ISIS

Reviewed by A. C. MOULE, *Journal of the Royal Asiatic society*, 161, 1933.

Takata Tadasuke. Kou tcheou p'ien 100 chapitres — 1 chapitre, préfaces, table des matières et préliminaires; Kou tcheou siu p'ien

pou, 10 chapitres en 2 boîtes ; Hio kou fa fan 8 chapitres en 1 boîte, Tôkyô, 1925. ISIS

Fundamental Japanese studies on ancient Chinese writing, elaborately reviewed by HENRI MASPERO, *Journal asiatique*, 210, 129-42, 1927.

Van den Wyngaert, Anastasius (O. F. M.). Sinica Franciscana, vol. II : Relationes et epistolas Fratrum Minorum saeculi XVI et XVII collegit, ad fidem codicum redegit et adnotavit. XLVI+662 p. QUARACCHI, 1933. ISIS

Reviewed by A. C. MOULE, *Journal of the Royal Asiatic society*, 872, 1934.

Waley, Arthur. The books of changes. *Bull. of the Museum of Far Eastern antiquities*, no. 5, Stockholm, 1934. ISIS

Reviewed by HENRI MASPERO, *Journal asiatique* 226, 170-73, 1935.

Waley, Arthur. The way and its power. A study of the *Tao tê ching* and its place in Chinese thought. London, ALLEN & UNWIN, 1934. ISIS

Wan Kuo-ting. Chung-kuo t'ien-chih shih (Agricultural history of China). Volume I, 394 p. Nan-ching shu-tien (Nanking Bookstore). Nanking, May 1933 (In Chinese). ISIS

Reviewed by A. W. HUMMEL, *Isis* 24, 155-57, 1935.

Ware, James Roland and **Weng tu-chien.** Index to Ssu k'u ch'uan shu tsung mu and Wei shou shu mu. 2 vols. X+VI+IV+II+195 p.; 210 p. (Harvard-Yenching Institute Sinological index series, no. 7). Published in Peiping Feb. 1932. Harvard University Press, Cambridge, Mass. $2.00. ISIS

" In 1773, Emperor CH'IEN LUNG began the collection of a selected library. All of the books were edited and copied by a board of several hundred scholars. The work took more than seventeen years, and resulted in seven duplicate sets of a collection of more than 3450 titles in more than 36,000 separate volumes, all hand-copied on more than 2,290,000 double-pages. A descriptive catalogue was published, giving information not only on these books but also on those not worthy to be included in the Imperial Library, making a total of 10,231 titles, each critically annotated. This is known at *Ssu K'u Ch'uan Shu Tsung Mu*, and is, according to ALEXANDER WYLIE, the Scotch Sinologue, one of the finest specimens of bibliography possessed by China, or perhaps any other nation. This catalogue in 200 parts is an indispensable book to every sinological scholar. Its method of classification, however, makes it difficult to locate a given author or title without considerable waste of time. The present Index in two volumes

will remedy this. It was first compiled by JAMES R. WARE, a Fellow of the Harvard-Yenching Institute and then expanded and revised by WENG TU-CHIEN, a senior in the College of Arts and Letters in Yenching University, who indexed also the *Wei Shou Shu Mu*, containing 175 books, at first intended to enlarge the Imperial Library. The manuscripts were again thoroughly edited by the Editorial Board of the Harvard-Yenching Institute Sinological Index series. Chinese characters are arranged according to the *Kuei Hsieh* system, but supplementary indices, according to Wade Romanization and the number of strokes, are provided to help those not familiar with the *Kuei Hsieh*. A table with formula will facilitate the application of the Index to the many different editions of the Catalogue. An introduction, written by the editor-in-chief, Prof. WILLIAM HUNG of Yenching University, gives a critical history of the Collection and of the text of the Catalogue."

Weig, Johann. Die chinesischen Familiennamen nach dem Büchlein Pai^{2} chia^{1} hsing^{4} (8556, 1139, 4599), nebst Anhang enthaltend Angaben über berühmte Persönlichkeiten der chinesischen Geschichte. X+286 p. Tsingtau, Missionsdruckerei, 1931. ISIS

Wu, Chao-Kwang. The international aspect of the missionary movement in China. IX+285 p. (Johns Hopkins Univ. studies in historical and political science. Extra vols., new series nr. 11). Oxford, University Press, 1930. ISIS

Reviewed by JOH. WITTE, *DLZ* 4, 532-34, 1933.

Yetts, W. Perceval. The horse : a factor in early Chinese history. *Eurasia Septentrionalis Antiqua*, 9, 231-55, 11 fig., 1934. ISIS

Reviewed by L. C. HOPKINS, *Journal of the Royal Asiatic society* 365-66, 1935. See also pp. 360-2. G. S.

Zenker, Ernest Victor. Histoire de la philosophie chinoise. Traduction par G. LEPAGE et YVES LE LAY. 527 p. (Bibliothèque historique). Paris, PAYOT, 1932. ISIS

11. — JAPAN

Anesaki, Masaharu. Art, life and nature in Japan. XI+178 p., pls. Boston, JONES, 1933. ISIS

Anesaki, Masaharu. A concordance to the history of Kirishitan missions (Catholic missions in Japan in the sixteenth and seventeenth centuries). 225 p., 1 map. (Proceed. of the Imp. Acad., Supplt. to vol. 6). Tokyo, Imperial Academy, 1930. ISIS

Reviewed by P. PELLIOT, *T'oung Pao*, 29, 122-25, 1932.

Berliner, Anna. Der Teekult in Japan. *Asia Major* 5, 281-488; 6, 113-297, 101 fig., 1930. ISIS

Bohner, Alfred. Wallfahrt zu Zweien. Die 88 heiligen Stätten von Shikoku. VI+158 p., 88 ills., 1 plan. (Supplement XII der Mitteilungen der deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens). Tokyo, 1931. ISIS

Reviewed by FLORENCE AYSCOUGH, *Journal of the Royal Asiatic society*, 206-07, 1933.

Bonneau, Georges. Yoshino, Collection pour la présentation de textes poétiques. Publication hors-série : La forêt des symboles, Introduction à l'idéographie japonaise. T. 1, Rythmes japonais, introduction aux rythmes 128 p. ; T. 2-4, Vingt-six syllabes (Dodoitsu) et chanson paysanne, 104+192+189 p. Paris, GEUTHNER, 1933. ISIS

Edo jidai no kagaku (Science during the Edo period, 1600-1867), prepared by the Tokyo Science Museum, 404 p., illus., pl. Tokyo, Hakubun-kan, 1934. ISIS

Reviewed by SHIO SAKANISHI, *Isis* 24, 159-60, 1935.

Eliot, Sir **Charles Norton E.** (1864-1931). Japanese Buddhism. XXXV+449 p. London, ARNOLD, 1935. ISIS

Ferrand, Gabriel. Le Wâqwâq est-il le Japon ? *Journal asiatique* 220, 193-243, 1932. ISIS

Fujikawa, Y. Japanese medicine. Translated from the German by JOHN RUHRÄH. With a chapter on the recent history of medicine in Japan by KAGEYAS W. AMANO. 8 ills. (*Clio medica*, 12). New York, HOEBER, 1934. ISIS

Fukukita, Yasunosuke. Cha-so-yu. Tea cult of Japan. XXXVI+112 p., pl. Tokyo, MARUZEN, 1932. ISIS

Graves, Mortimer (editor). Abstracts of articles appearing in current Japanese periodicals. Tentative publication for criticism and comment. II+73 p. Washington, D. C., American Council of Learned Societies, 1935 (mimeographed, 50 cents). ISIS

" The series of abstracts here presented is the first-fruits of an experiment in making available to Western scholars materials of scientific importance

published in languages having little diffusion in the Occident. The young American scholars whose names appear at the heads of the separate abstracts were asked in 1934 if they would participate in this experiment by reading regularly Japanese periodicals in the fields of their own interests and preparing abstracts for general dissemination." ... "This first tentative result is presented *for criticism*. If the reaction is favorable, effort will be made to continue the series, to provide Chinese or Japanese characters and to include materials published in Chinese and Russian. It is hoped that these abstracts will be useful, not primarily to sinologues and japanists, but to scholars in the more usual fields of study who find some contact with Far Eastern materials valuable."

Some of the items are referred to in the present bibliography. We earnestly hope that these efforts may be continued. G. S.

Grousset, René. Les civilisations de l'Orient. Vol: 4, Le Japon. VIII+319 p. Paris, CRÈS, 1930. ISIS

Reviewed by S. YOSHITAKE, *Bull. of the school of oriental studies* 6, 814-16, 1931.

Haguenauer, M. C. Notions d'archéologie japonaise. IV+68 p., 6 pl., 2 maps. Tokyo, *Bull. Maison franco-japonaise*, 3, 1931. ISIS

Reviewed in *T'oung Pao*, 29, 189, 1932.

Haguenauer, M. C. Two lectures on prehistoric and proto-historic Japanese civilization. 25 p. Tokyo, Maison Franco-Japonaise, 1931. ISIS

Reviewed in *T'oung Pao*, 29, 191, 1932.

Hamada, Kosaku; Umehara, Sueji. Shiragi ko-ga no kenkyû. Study on the ancient tiles of the Silla dynasty with a *corpus* of ancient tiles of the Silla. Report upon archaeological research in the Dept. of Literature, Kyoto Imperial University. Vol. 13, 118 p., 76 pl. Tokyo, Tokô Shoin, 1934. ISIS

Reviewed by SHIO SAKANISHI, *Journal of the American Oriental society* 55, 218-19, 1935.

Hôbôgirin. Dictionnaire encyclopédique du Bouddhisme d'après les sources chinoises et japonaises, fascicule annexe : tables du *Taisho Issaikyo*. 202 p. Tokyo, Maison Franco-Japonaise, 1931. ISIS

Reviewed by C. A. F. RHYS DAVIDS, *Journal of the Royal Asiatic society* 134, 1933.

Ichida, Asajirô. A relation between IWATA's and ÔHARA's theorems

in the old Japanese mathematics. *Tôhoku Math. journal* 37, 199-201, 1933. ISIS

Isemonger, Noel Everard. The elements of Japanese writing. VII+253 p. (*James G. Forlong fund publications*, 8). London, Royal Asiatic Society, 1929. ISIS

Reviewed by H. A. M., *Journal of the Royal asiatic society*, 694-96, 1930.

(Japan). Nippon kotoki taihan. Methods of lighting in ancient Japan. Small book of text in Japanese with English summary dated Dec. 1936. Published by Japanese illuminating engineering society. ISIS

Large collection of archaeological documents concerning the evolution of methods of artificial lighting. Loose plates in book. Japanese and English legends. G. S.

Koidzumi, Akio. Lo-lang : the tomb of the painted basket and other two tombs, being a report of the excavations in the season of 1931. English résumé by KÔSAKU HAMADA. 150+28 p., 133 pl., 50 ills. Keijo (Seoul), Society of the study of Korean antiquities, 1934. ISIS

Reviewed by ELLIS H. MINNS, *Antiquity* 9, 251, 1935.

Koidzumi, Geniti. The early history of European botanical observations on the flora of Japan. *Acta Phytotax et Geobot.* 1, 1-10, 1932. ISIS

Kurth, Julius. Die Geschichte des japanischen Holzschnitts. Vol. I, Einleitung. Von den Anfängen bis HARUNOBU ; II, Von HARUNOBU bis EISHI ; III, Von der Sekien-schule bis zu den Hiroshige. Leipzig, HIERSEMANN, 1925-29. ISIS

Mody, N. H. N. A collection of Japanese clocks. XIV+27 p. (Eng.). 27 p. (Jap.), 135 pl. London, KEGAN PAUL, 1932. ISIS

Reviewed by LUDWIG BACHHOFER, *OLZ* 37, 194, 1934.

Nachod, Oskar (1858-1933). Geschichte von Japan, II. Band : Die Übernahme der chinesischen Kultur (645-ca. 850), I. Hälfte, Teil 1 : Die Entwicklung vom Geschlechterstaat zum Beamtenstaat (Taikwa-Reform) 645-700, 1929 ; II. Hälfte, Teil II : Die Durchführung des Beamtenstaates 700-ca. 850, hrsg. vom Japaninstitut in Berlin. 2 vol., XXXII+1179 -A64 p., map. Leipzig, *Asia Major*, 1906-29. ISIS

Reviewed by E. GASPARDONE, *Bulletin de l'école française d'Extrême-Orient* 31, 256-58, 1932.

Nakaya, Jiujiro. Manuel de l'age de pierre au Japon. 581 p. 1 pl., 1 map, 57 fig. Tokyo, édition Oka, 1929. ISIS

Reviewed by GEORGES-HENRI RIVIÈRE, *Revue des arts asiatiques* 6, 130, 1930.

Oka, Fuhô. Manyô Sômoku-Kô (The plants mentioned in the Manyô-Ahû) (in Japanese). Vol. 1, 707 p., 3 frontispieces, 61 fig. Tokyo, The Kensetsusha, 1932. ISIS

Reviewed by YOSHIO MIKAMI, *Archeion* 14, 334, 1932.

Okamoto. A catalogue of Japanese mathematical literature. Preface by FUJISAWA RIKITARO. 822 p. Tokyo, Herald Press, 1931. ISIS

Reviewed by C. P. WONG, *Scripta mathematica* 1, 261, 1933.

Ruijû kokushi. (Classified national history) no. 171, Sai-i bu (Natural calamities), part 5 : On earthquakes. A scroll with a folded explanatory text. Tokyo, Ikutoku Foundation, 1933 (in Japanese). ISIS

Reviewed by SHIO SAKANISHI, *Isis* 24, 158, 1935.

Sadler, Arthur Lindsay. Cha-no-yu. The Japanese tea ceremony. 259 p., 280 ills., 5 pl. London, KEGAN PAUL, 1934. ISIS

Sakanishi, Shio ; Addington, Marion H. ; Perkins, P. D. A list of translations of Japanese drama into English, French, and German. Tentative edition for checking and criticism. VIII + 89 p. Washington, D.C., American Council of Learned Societies, 1935 (mimeographed, 50 cts.). ISIS

This elaborate bibliography will be a revelation to readers, very few of which realized the abundance of material already available. I missed the folio volume on *Kabuki* by SERGEI GRIGOR'EVICH ELISEEV (Paris 1933) including admirable illustrations (32 col. plates) by ALEKSANDER IAKOVLEV.
G. S.

Sakanishi, Shio. The magic holly in Japanese literature. *Journal of the American Oriental society* 55, 444-50, 1935. ISIS

" From primitive times to the present, holly in Japan has been vested with a certain magic power. Although the rites and ceremonies connected with it came from China originally, its cult is indigenous to Japan, and finds closer parallels in Western folklore."

Sansom, George Bailey. Japan : a short cultural history. XVI+537 p. 55 ills, 19 pls. (The Cresset historical series). London, Cresset Press, 1931. ISIS

Reviewed by G. F. HUDSON, *Journal of the Royal Asiatic Society*, 860-62, 1934.

Suski, Peter Marie. The phonetics of the Japanese language with reference to Japanese script. 122 p. Los Angeles, Science Society, 1931. ISIS

Reviewed by H. PARLETT, *Journal of the Royal Asiatic Society*, 133-34, 1933.

Toda, Kenji. Japanese scroll painting. IX+167 p., 19 pl., map. Chicago, University Press, 1935. ISIS

Uyeda, Sanpei. Nihon yakuen-shi no kenkyû (Historical study of the Japanese herb gardens). 263 p., 77 ills., 44 pl. Tokyo, Sanshû-sha, 1930. ISIS

Reviewed by SHIO SAKANISHI, *Isis* 24, 160-62, 1935.

Visser, Marinus Willem de. Ancient Buddhism in Japan. Sutra and ceremonies in use in the seventh and eighth centuries A.D. and their history in later times. Vol. 1. X+423 p. (*Buddhica*, 3). Paris, GEUTHNER, 1931. ISIS

Reviewed by P. PELLIOT, *T'oung Pao* 28, 428-36, 1931.

12. — ISRAEL

(*Including works devoted to Palestine*)

Barrois, H. La métrologie dans la Bible. *Revue biblique* 40, 185-213, 1931. ISIS

Bloch, Joshua. Venetian printers of Hebrew books. *Bulletin of the New York Public Library*, 24 p., Feb. 1932. ISIS

Bloch, Joshua. GINSBURG's Massoretic Bible. *Bulletin of the New York Public Library*, 6 p., Sept. 1928. ISIS

Bloch, Joshua. Jewish life in oriental countries. A list of books and manuscripts exhibited at the New York Public Library, March 30th to December 31st, 1926. 15 p. *Bulletin of the New York Public Library*, Nov. 1926. ISIS

Bulard, Marcel. Le scorpion symbole du peuple juif dans l'art religieux des XIV^e^, XV^e^, XVI^e^ siècles. XV+364 p., 50 pl. Paris, DE BOCCARD, 1935. ISIS

Reviewed by A. RENAUDET, *Journal des savants*, 171-75; and by J. CHAMONARD, *Revue de l'hist. des religions* 112, 290-92, 1935.

Gandz, Solomon. Oral tradition in the Bible. *Jewish studies in memory of George A. Kohut*, 248-69, New-York, 1935. ISIS

"Jewish tradition has it that the Jews received two laws, the written and the oral law. The written law is contained in the Bible; the oral law, interpreting and supplementing the former, is incorporated in Mishnah and Talmud, and was later reduced to writing. Thus the written law is commonly understood to precede, in time and in rank, the oral law. History in general, however, teaches us that there are four phases in the development of literature and tradition: (1) The primordial phase of oral tradition prevailing among all the nations before the invention or introduction of writing. (2) The introduction of writing and written literature. Usually, written literature sets in with a great religious book, like the Bible, the Vedas, the Quran, the New Testament, or also with a great national epic, like HOMER. (3) The secondary phase of oral literature, coming after the first Holy Scriptures as a continuation of old habits, or, still later, as a movement to revive and restore old customs. In the history of civilization written literature first appears as a short episode, an isolated fact, a revolutionary innovation introduced by some great founder of religion, or prince and legislator. The people at large very stubbornly continue their old habits of preserving their lore and tradition by memory. Only very slowly and gradually do they learn to read and write and to appreciate a written literature, and thus attain the stage (4) in which the use of written literature is the general rule."

Schonfield, Hugh J. The new Hebrew typography. With an introduction by STANLEY MORISON and numerous types designed by the author and drawn by BERTRAM F. STEVENSON. 51 p. London, ARCHER, 1932. ISIS

"In modernising Hebrew typography, the formidable task has to be undertaken of formulating a principle of design which will permit of a variety of styles for all printing purposes, of creating a complete set of Hebrew capitals and lower-case letters which will retain their general integrity of form in either serif, sans-serif, grotesque or any other decorative treatment, and of introducing a fluidity which will make for easy reading."

Yūsuf Rizqallāh Ghanīma. Nuzhat al-mushtāq fī ta'rīkh yahūd al-'Irāq. 8+224 p., ills. Maṭba'at al-furāt (Printing Press Euphrates). 1342 = 1924. (in Arabic). ISIS

Brief analysis by JOSHUA FINKEL in *Jewish quarterly review* 26, 237-39, 1936. I have a copy of this book which I would gladly lend to collaborators. G. S.

14. — ISLAM
(*Also Arabia*)

Asín Palacios, Miguel. La tesis de la necesidad de la revelación, en el Islam y en la escolástica. *Al-Andalus* 3, 345-89, 1935. ISIS

Dja'far Abd-el-Kader. Deux unités pondérales musulmanes omayyades. *Berytus* 2, 139-42, 6 fig., 1935. ISIS

Farmer, Henry George. Turkish instruments of music in the seventeenth century. *Journal of the Royal Asiatic society* 1-43, 1936. ISIS

Renaud, H. P. J. Les origines de la médecine arabe en Espagne. *Bull. de la soc. franc. d'hist. de la méd.* 29, 321-32, 1935. ISIS

Ritter, Helmut ; Walzer, Richard. Arabische Übersetzungen griechischer Ärzte in Stambuler Bibliotheken. *Sitzungsberichte der preussischen Akademie der Wissenschaften*, phil.-hist. Kl. 26, 801-46, 1934. ISIS

Süheyl, A. Sur l'histoire des hôpitaux en Turquie du moyen âge jusqu'au XVII[e] siècle. Comptes rendus du IX[e] Congrès international d'histoire de la médecine 16 p., ills. Bucarest, 1932. ISIS

Terrasse, Henri. Orientation du miḥrāb dans les mosquées (*Isis* 20, 262-4). Réponse à la question n° 25. *Isis* 24, 109, 1935. ISIS

PART III

SYSTEMATIC CLASSIFICATION

I. — SCIENCE IN GENERAL

16. — HISTORY OF SCIENCE

Académie internationale d'histoire des sciences. Elections de 1935. *Isis* 24, 125, 1935. ISIS

Barnes, Sherman B. The editing of early learned journals. *Osiris* 1, 155-72, 1936. ISIS

" This article discusses certain difficulties and problems which confronted

the editors of some early learned journals. Though over 300 such periodicals were founded before 1730, the most important, judged by duration and content, were the *Journal des sçavans* (1665-), the *Philosophical transactions* (1665-), and the *Acta Eruditorum* (1682-1776). The most popular of the semi-learned serials were the *Mercure Galant* (1672-), and the *Nouvelles de la République des lettres*, which, when edited by PIERRE BAYLE (1684-87), was intended to compromise between the *Journal des Sçavans* and the *Mercure Galant*." "The following details, it is hoped, may serve those interested in the history of scholarship and the relation thereto of the publishing business."

Collier, Katherine Brownell. Cosmogonies of our fathers. 500 p. New York, Columbia University Press, 1934. ISIS

Reviewed by ROBERT K. MERTON, *Isis* 24, 167-68, 1935.

Crommelin, Claude August. Nieuwe denkbeelden en geestelijke verkeersmiddelen op het gebied der natuurwetenschappen in de XVII^e^ en XVIII^e^ eeuw. *De Gids*, 196-214, Feb. 1934. ISIS

Crommelin, Claude August. Stichting het Nederlandsch historisch natuurwetenschappelijk museum te Leiden. Gids door de CHRISTIAAN HUYGENS verzameling en door de afdeelingen voor natuurkunde sterrekunde, aarmeetkunde en microscopen. 16 p. Leiden, IJDO, 1931. ISIS

Fettweis, Ewald. Bericht über die Stellung der Wissenschaftsgeschichte im Unterricht der höheren Schulen Deutschlands. *Archeion* 17, 213-17, 1935. ISIS

Metzger, Hélène. La settimana della Scuola di storia delle scienze a Roma. *Archeion* 17, 203-12, 1935. ISIS

Osiris. Studies on the history and philosophy of science and on the history of learning and culture. Edited by GEORGE SARTON. Vol. I. A volume of studies on the history of mathematics and the history of science, presented to DAVID EUGENE SMITH on his 76th birthday (Jan. 21, 1936). Edited by GEORGE SARTON, with the cooperation of R. C. ARCHIBALD, Miss B. M. FRICK, and A. POGO. 777 p., 22 pl., 35 facs., 24 fig. Bruges, Ste. Catherine Press, 1936 ($6; $5 to members of the H. S. S.). ISIS

Quintana y Mari, Antonio. Valor de la historia de la ciencia como medio de educación integral y específica del individuo. *Archeion* 17, 218-23, 1935. ISIS

Reymond, Arnold. Les étapes de la pensée scientifique. *Archeion* 17, 133-48, 1935. ISIS

Ratner, Sidney. Evolution and the rise of the scientific spirit in America. *Philosophy of science* 3, 104-22, 1936. ISIS

Sabin, Florence R. Women in science. *Science* 83, 24-26, 1936. ISIS

Apropos of M^me^ CURIE, AGNES POCKELS and EMMY NOETHER.

Sarton, George. Introduction to the history of science, vol. 2, From RABBI BEN EZRA to ROGER BACON. XXXV+1251 p. Baltimore, WILLIAMS & WILKINS, 1931. ISIS

Reviewed by JOSHUA FINKEL, *Jewish quarterly review* 26, 227-33, 1936.

Sarton, George. Forty-third Critical bibliography of the history and philosophy of science and of the history of civilization (to end of February 1935—with special reference to the fourteenth century and Asia). *Isis* 24, 192-303, 1935. ISIS

"This forty-third Bibliography contains about 630 items of which 170 deal with the fourteenth century and with Asia. They have been kindly contributed by eight scholars belonging to 3 different countries."

Sigerist, Henry E. Preface to volume IV : the history of medicine and the history of science. An open letter to GEORGE SARTON, Editor of *Isis*. *Bulletin of the Institute of the history of medicine* 4, 1-13, 1936. ISIS

A forceful and witty defense of medicine elicited by SARTON's article "The history of science versus the history of medicine." It is clear that SARTON and SIGERIST are in agreement with regard to essentials. G. S.

Tannery, Paul (1843-1904). Mémoires scientifiques publiés par J.-L. HEIBERG et H.-G. ZEUTHEN. Vol. XII : Comptes rendus et analyses. 1896-1904. Vol. XIII : Correspondance. Editée par A. DIÈS, XXIII+518 p.; XXXI+503 p., 6 pl. Toulouse, PRIVAT, 1933-4. ISIS

Reviewed by GEORGE SARTON, *Isis* 24, 162-63, 1935.

Van Alphen, J.; Crommelin, C. A.; Van der Klaauw, C. J. Het Nederlandsch historisch natuurwetenschappelijk museum te Leiden. *Chemisch weekblad* 31, 323-25, 1934. ISIS

Wolf, A. A history of science, technology, and philosophy in the 16th & 17th centuries. With the co-operation of F. DANNEMANN, and A. ARMITAGE. XXVII+692 p., 316 ills. London, ALLEN & UNWIN, 1935. ISIS

Reviewed by GEORGE SARTON, *Isis* 24, 164-67, 1935 and by ALDO MIELI, *Archeion* 17, 275-82, 1935.

Zia, Hilmi. Türk Teffekürü Tarihi (Histoire de la pensée turque). 2 vol. 535 p. Istanbul, Ebuzzia, 1933. ISIS

Reviewed by A. ADNAN, *Archeion* 17, 288-91, 1935.

17. — ORGANIZATION OF SCIENCE

(Internal organization is meant, see Isis 1, 195. *For external organization, national, or international, see section* 55)

Hopkins, Sir **Frederick Gowland.** Science in modern life. *Nature* 136, 893-95, 1935. ISIS

From the anniversary address to the Royal Society, delivered on November 30, 1935.

Huxley, Julian. Science and social needs. With an introductory chapter by Sir WILLIAM BRAGG, and discussions with H. LEVY, Sir THOMAS D. BARLOW, and P. M. S. BLACKETT. XVI+287 p., 41 pl. New York, HARPER, 1935. ISIS

Reviewed by ROBERT K. MERTON, *Isis* 24, 188, 1935.

18. — PHILOSOPHY OF SCIENCE

Hostelet, Georges. Confrontation entre la méthodologie scientifique des faits de nature et celle des faits d'activité humaine. Comptes Rendus, 2e Congrès national des sciences, organisé par la Fédération belge des sociétés scientifiques, 60-67, Bruxelles, 1935. ISIS

Hostelet, Georges. La méthodologie scientifique de l'investigation des faits de la nature et des faits de l'activité humaine. *Bulletin de la Société française de philosophie* 35, 1-3, 1935. ISIS

Nelson, Everett J. A note on parsimony. *Philosophy of science* 3, 62-66, 1936. ISIS

Thorndike, Edward L. Science and values. *Science* 83, 1-8, 1936. ISIS

Address of the retiring president of the American Association for the Advancement of Science, St. Louis, December 30, 1935.

Wheeler, Raymond Holder. Organismic logic in the history of science. *Philosophy of science* 3, 26-61, 1936. ISIS

II. — FORMAL SCIENCES
(Knowledge of forms)

19. — LOGIC AND THEORY OF KNOWLEDGE

Kattsoff, Louis Osgood. Postulational methods, II. *Philosophy of science* 3, 67-89, 1936. ISIS

Keyser, Cassius Jackson. Three great synonyms : relation, transformation, function. *Scripta mathematica* 3, 301-16, 1935. ISIS

Quine, Willard Van Orman. A system of logistic. x+204 p. Cambridge, Mass., Harvard University Press, 1934. ISIS

Reviewed by HENRY S. LEONARD, *Isis* 24, 168-72, 1935.

20. — MATHEMATICS

Bortolotti, Ettore. L'algebra nella storia e nella preistoria della scienza. *Osiris* 1, 184-230, 1936. ISIS

Contents : 1. L'Algebra nel libro di MUHAMMED BEN MUSA; 2. L'Arimetica di DIOFANTO; 3. L'Algebra geometrica; 4. Ulteriori progressi della Regola d'algebra, il Calcolo algebrico e la Regula modi; 5. L'Algebra nell'antico Egitto; 6. L'arithmetica babilonese; 7. L'algebra babilonese; 8. Conclusioni.

Coolidge, Julian L. The origin of analytic geometry. *Osiris* 1, 231-50, 1936. ISIS

"I find on the whole something very disappointing in a general early history of analytic geometry. The progress in the seventeenth and eighteenth centuries was almost negligible compared to what was done in the nineteenth. I think the explanation must be that the discoveries of FERMAT and DESCARTES came too near in time to those of LEIBNITZ and NEWTON. The infinitesimal calculus was of such transcendent importance as to absorb the best energies of the greatest mathematical minds. It was only when the calculus had really come into its own that geometry could receive the attention which its importance and its beauty deserved."

Davis, Harold T. A course in general mathematics. xi+316 p., 3 fig. Bloomington, Indiana, Principia Press, 1935. ISIS

A very ingenious exposition of arithmetic, algebra, trigonometry, of a little analytical geometry, of functional relationships, and statistics. A final chapter discusses the meaning of mathematics, and there are enough historical notes *passim* to give the thoughtful student some feeling of tradition and continuity. As the author says, "All teaching becomes richer from some contact and familiarity with historical origins." G. S.

Frick, Bertha Margaret. The DAVID EUGENE SMITH mathematical library of Columbia University. *Osiris* 1, 79-84, 1936. ISIS

Gomes Teixeira, Francisco. História das matemáticas em Portugal. VI+300 p., Lisbon, Academia das Cieñcias, 1934. ISIS

Reviewed by ALDO MIELI, *Archeion* 17, 291-95, 1935.

Mitchell, U. G.; Strain, Mary. The number *e*. *Osiris* 1, 476-96, 1936. ISIS

Contents: I. Introduction, 1. The numbers e and π: II. First approximations to the number e: 2. First natural logarithms. 3. Relations of logarithms to the hyperbola; 4. Development of the exponential series; 5. Association of logarithms and exponents; III. Recognition of the existence of e: 6. The work of EULER; 7. Representation as a limit; 8. Representation by a symbol; 9. Later approximations to e. IV. The nature of e: 10. Proof of irrationality; 11. Proof of transcendence.

Sarton, George. Les azulejos géométriques de Coimbra. *Query* no. 51. *Isis* 24, 106, 1935. ISIS

Simons, Lao Genevra. Short stories in colonial geometry. *Osiris* 1, 584-605, 1936. ISIS

Contents: The story of geometry at Harvard College; The story of geometry at Yale College; The story of geometry at Columbia College; The University of Pennsylvania; Conclusion.

(Smith, David Eugene). Bibliography of the critical, historical and pedagogical writings of DAVID EUGENE SMITH. Compiled by BERTHA MARGARET FRICK. *Osiris* 1, 9-78, 1936. ISIS

(Smith, David Eugene). The DAVID EUGENE SMITH gift of historical-mathematical instruments to Columbia University. *Science* 83, 79, 1936. ISIS

Smith, David Eugene. Changes in elementary mathematical terms in the last three centuries. *Scripta mathematica* 3, 291-300, 1935. ISIS

Smith, David Eugene. The poetry of mathematics and other essays. IV+90 p. (*Scripta mathematica library*, 1). New York, Scripta Mathematica, Yeshiva College, 1934. ISIS

Reviewed by E. T. BELL, *American mathematical monthly* 42, 558-62, 1935.

Smith, David Eugene. Certain questions in the history of mathematics. *Bull. Calcutta Math. Soc.* 20, 135-38, 1930. ISIS

Vetter, Quido. Le deuxième Congrès des mathématiciens des pays slaves, Prague, 23-28, Septembre 1934. *Enseignement mathématique* 33, 367-71, 1934. ISIS

Vetter, Quido. Matematické vědy v. klášterech jezovitských na půdě republiky Československé. Comptes-rendus du deuxième congrès des mathématiciens des pays slaves, 263-64, Praha, 1935. ISIS

Vetter, Quido. Trois remarques sur l'histoire des mathématiques. *Mathematica* 9, 304-09, Cluj, 1935. ISIS

Vetter, Quido. Relations mathématiques entre les pays Tchèques et les pays de la Péninsule Ibérique, l'Amérique et l'Extrème Orient. Actes, conférences et communications du III[e] Congrès international d'histoire des sciences, tenu au Portugal en 1934, 8 p., Lisboa, 1935. ISIS

III. — PHYSICAL SCIENCES
(Knowledge of inorganic nature)

23. — ASTRONOMY

Jeans, Sir James. The size and age of the universe. *Nature* 137, 17-24, 3 fig., 1936. ISIS

Discourse delivered at the Royal Institution on November 29, 1935.

Nordlinger, H. H. Some modern methods of measuring the sidereal universe. *Scripta mathematica* 3, 317-25, 1935. ISIS

Pogo, Alexander. Calendar years with five solar eclipses. *Popular astronomy* 43, 412-23, 2 diagr., 1935. ISIS

The fifth of a series of papers dealing with the periodicity of groups of eclipses (*Isis* 24, 271). "The problem of periodicity of calendar years with 7 eclipses is one of the simpler aspects of a more complex problem

—the correlation between periodic celestial phenomena, on the one hand, and various systems of chronology, on the other. The chronological systems considered in the present paper are the Julian and the Gregorian calendars, extrapolated both into the past and into the future..." "From the point of view of Old World calendariography, a period of 65 years (804 lunations) is the difference between the Roman cycle of 84 years (1039 lunations) and the Metonic cycle of 19 years (235 lunations)." A. P.

Pogo, Alexander. Calendar years with three lunar eclipses. *Popular astronomy* 43, 549-57, 2 diagr., 1935. ISIS

The sixth of a series of papers dealing with the periodicity of groups of eclipses (*Isis* 24, 271). It includes a discussion of the "hexa-Callippic" cycle of 456 years (5640 lunations) which corresponds to 6 Callippic cycles of 76 years (940 lunations) or to 24 Metonic cycles of 19 years (235 lunations). A. P.

Pogo, Alexander. The eclipse of 1935 December 25—an umbral eclipse of the midnight sun in the Antarctic. *Popular astronomy* 43, 617-27, 2 diagr., 1935. ISIS

The seventh of a series of papers dealing with the periodicity of groups of eclipses (*Isis* 24, 271). It includes a discussion of the period of 595 years (33 saroses) and of the seasonal variation of the duration of the interval (average duration, 6585 1/3 d.) between successive eclipses of a saros series. A. P.

24. — PHYSICS

Crommelin, Claude August. Kunstmatige koude in vroeger tijden. *Koeltechniek* 4, 86-87, 1933. ISIS

On refrigeration in ancient times.

Crommelin, Claude August. Meten en wegen de beteekenis van de quantitatieve bepaling voor de ontwikkeling der natuurwetenschappen in de XVII*e* en XVIII*e* eeuw. *Nederlandsch tijdschrift voor natuurkunde* 1, 145-57 (no date). ISIS

Kennelly, Arthur E. Adoption of the meter-kilogram-mass-second (M. K. S.) absolute system of practical units by the international electrotechnical commission (I. E. C.), Bruxelles, June 1935. *Proceedings of the National Academy of Sciences* 21, 579-83, 1935. ISIS

Mitkevitch, V. Th. The electromotor in its historical development. Documents and materials collected by D. V. EFREMOV and

M. I. RADOVSKIJ. XIV+660 p., 48 fig. Transactions of the institute for the history of science and technology, series 3, issue 2, Moscow, Academy of science Press, 1936. ISIS

This rich collection beginning with FARADAY 1822, PETER BARLOW 1824, JOSEPH HENRY 1831, etc. and ending with MARCEL DEPREZ 1882, contains every document in the original text and in translation. It will be continued, and is itself a continuation of a work by the same authors on the history of the dynamo (Leningrad 1934; *Isis* 24, 233, 518). G. S.

Richtmyer, Floyd Karker. Introduction to modern physics. 2nd edition. XVIII+747 p. New York, MCGRAW-HILL, 1934. ISIS

Reviewed by G. S., *Isis* 24, 172-74, 1935.

25. — CHEMISTRY, PHYSICO-CHEMISTRY, INDUSTRIAL CHEMISTRY

Donald, M. B. History of the Chile nitrate industry. 1. *Annals of science* 1, 29-47, 1 pl., 2 fig., 1936. ISIS

Hopkins, Arthur John. Alchemy, child of Greek philosophy. XI+262 p. New York, Columbia University Press, 1934. ISIS

Reviewed by W. J. WILSON, *Isis* 24, 174-77, 1935.

Leroux, Lucien. La guerre chimique. Deuxième édition revue et augmentée. 163 p. Paris, SPES, 1933. ISIS

La guerre chimique n'est pas une nouveauté, les Athéniens l'employèrent dans la guerre du Péloponèse en 431 av. J.-C. et les Indiens y étaient experts, mais depuis l'initiative allemande du 23 avril 1915 elle est devenue infiniment plus redoutable et plus compliquée. Le beau livre de M. LEROUX nous permet d'envisager cette question sur toutes ses faces. 1. Les armes chimiques; 2. La fabrication des armes chimiques; 3. L'organisation d'une guerre chimique; 4. L'emploi des armes chimiques; 5. Les effets de la guerre chimique; 6. La protection; 7. La guerre bactériologique; 8. La Société des Nations et les groupements contre la guerre chimique; 9. Stratégie et politique chimiques. G. S.

Lippmann, Edmund O. von. Das Leuchten des Zuckers. *Pharmazeutischen Industrie* Nr. 2, 3 p., (no date). ISIS

Stein, O. References to alchemy in Buddhist Scriptures. *Isis* 24, 119, 1935. ISIS

26. — TECHNOLOGY

(*For mining, see* 32. *geology*; *for industrial chemistry*, 25. *chemistry*. *See also Arts and crafts, under* 45)

Dickerman, William Carter. Steam and the railroads. 22 p. Princeton University Press, 1936. ISIS

An address delivered by invitation at the Bicentenary banquet held at the Bellevue-Stratford Hotel in Philadelphia, on January 21, 1936, being the concluding event in The Watt Bicentenary in the United States.

Jacobi, Heinrich. Der keltische Schlüssel und der Schlüssel der Penelope, ein Beitrag zur Geschichte des antiken Verschlusses. *Schumacher-Festschrift*, 213-32, 4 fig., Mainz, 1930. ISIS

Shaw, Ralph R. Engineering books available in America prior to 1830. 69 p. New York, Public Library, 1933. ISIS

Smorgonsky, I. Foreign shipbuilding terms in the Russian language. With a preface by A. N. KRILOFF. XV+180 p. (Academy of sciences of the USSR, *Transactions of the Institute for the history of science and technology series* 2, issue 6), Moscow, 1936. (In Russian). ISIS

Strumilin, S. G. Fortschritte der Technik in den letzten 3 Jahrhunderten. *Archives of the history of science & technology* vol. 5, 435-72, Leningrad, 1935 (to be continued. In Russian). ISIS

Usher, Abbott Payson. A history of mechanical inventions. X+401 p., 148 fig. New York, MCGRAW-HILL, 1929. ISIS

Reviewed by R. K. MERTON, *Isis* 24, 177-80, 1935.

IV. — BIOLOGICAL SCIENCES
(Knowledge of organic nature)

27. — BIOLOGY
(*Generalities, "Natural history"*)

Haldane, John Scott. The philosophy of a biologist. XII+155 p. London, MILFORD, 1935. ISIS

Böhner, Konrad. Geschichte der Cecidologie. Ein Beitrag zur Entwicklungsgeschichte naturwissenschaftlicher Forschung und ein

Führer durch die Cecidologie der Alten. Mit einer Vorgeschichte zur Cecidologie der klassischen Schriftsteller von FELIX VON ÖFELE. 1. Bd. Allgemeiner Teil, XXVII+466 p., 27 fig. 2. Bd. Besonderer Teil, 712 p., 138 fig. Mittenwald, Bayern, NEMAYER, 1933-35. ISIS

Reviewed by GEORGE SARTON, *Isis* 24, 180-83, 2 fig., 1935.

28. — BOTANY

(*Agronomy, phytopathology, palaeobotany*)

Bower, F. O. A century of botany, 1835-1885-1935. *Nature* 136, 938-41, 976-78, 1935. ISIS

Renaud, H. P. J. Introduction des cactus et autres cactacées en Europe (*Isis* 20, 442). Réponse à la question no. 33. *Isis* 24, 110-13, 1935.

Wheelwright, Edith Grey. The physick garden. 288 p., 17 pls. Boston, HOUGHTON MIFFLIN, 1935 ($3.00). ISIS

Fittingly figured in the frontispiece is a well known statue of AESCULAPIUS having the serpent of the Caduceus with an herb in its mouth. The book contains brief accounts of aboriginal uses of herbs, of the drug plants of Mesopotamia, India, and China, of the Egyptian records of medicinal plants, and of the drugs in Greek medicine, the Roman period, and in the early Christian era. Medicine was at a low level in Anglo-Saxon times but Irish missionaries at St. Gall in Switzerland are reputed to have had a physick garden and a hospital. Accounts are given of the herbals of Continental countries and of England and of the increase of interest in botanic gardens in the 16th century with the importation of plants from newly explored lands. Between 1533 and 1598 botanic gardens were established at Padua, Florence, Bologna, Paris, and Montpellier, and between 1628 and 1678 at Jena, Oxford, Uppsala, Leyden, Chelsea and Edinburgh. Navigators and explorers searched for "sundrie herbes" in "newefound worlds," and quinine guaiacum, sassifras, and ipecacuanha began to be imported. Note is made of the English herbals, botanic gardens and gardeners, and the use of pharmacopoeias, the first under legal auspices being that of Nuremberg in 1542, and the first English one being that of London in 1618. The London, Dublin, and Edinburgh Pharmacopoeias were combined in the British in 1864. The author gives accounts of the medicinal plants of Great Britain, the trade in medicinal herbs and their sources in various countries, drug farms in Great Britain, and the sporadic growth of popular interest in herbgrowing resulting from the World War. C. A. K.

29. — ZOOLOGY

Gudger, Eugene W. The geographical distribution of the whale-shark (*rhineodon typus*). *Proceedings of the Zoological society of London*, 1934, 863-93, 1 pl. 2 fig., printed 1935. ISIS

Gudger, Eugene W. Horseshoe crabs with forked tails. *Bulletin New York Zoological Society* 38, 170-73, 1935. ISIS

Gudger, Eugene W. How rats transport eggs. The rat-egg-wagon story traced back to 1291 A.D. *Scientific monthly* 40, 415-24, 1935. ISIS

Gudger, Eugene W.; **MacDonald, Samuel M.** The rarest of the ocean sunfishes. *Scientific monthly* 41, 396-408, 1935. ISIS

Gudger, Eugene W. Coelenterates as enemies of fishes — 1. Hydras and sessile colonial hydroids as fish-eaters. *Annals and Magazine of natural history* 13, 192-212, 2 pl. 7 fig., 1934. ISIS

Gudger, Eugene W. Coelenterates as enemies of fishes. II. Jellyfishes as fish-eaters. *Bulletin New York Zoological society* 37, 47-58, 16 fig., 1934. ISIS

Gudger, Eugene W. Jenny Hanivers, dragons and basilisks in the old natural history books and in modern times. *Scientific monthly* 38, 511-23, 1934. ISIS

Gudger, Eugene W. Abnormalities in flatfishes (*heterosomata*). I. reversal of sides. A comparative study of the known data. *Journal of morphology* 58, 39 p., 5 fig., 1935. ISIS

Herrick, Francis Hobart. The American eagle, a study in natural and civil history. XXII+267 p., 32 pl., 24 fig. New York, Appleton-Century, 1934. ISIS

Reviewed by C. A. KOFOID, *Isis* 24, 183-84, 1935.

Meyer, A. W. Some historical aspects of the recapitulation idea. *Quarterly review of biology* 10, 379-96, 1935. ISIS

V. — SCIENCES OF THE EARTH

(Implying knowledge of both organic and inorganic nature)

30. — GEODESY

Taylor, E. G. R. Some notes on early ideas of the form and size of the earth. *Geographical journal* 85, 65-8, 1935. ISIS

Analysis of evidence from manuscripts in the British Museum, of the period A. D. 900-1500. Five reproductions and a table summarising results. C. W. A.

31. — GEOGRAPHY AND OCEANOGRAPHY

Crommelin, Claude August. Over Nederlandsche, in het bijzonder Amsterdamsche, globes uit de XVI*e*, XVII*e* en XVIII*e* eeuw. *Natuur en Mensch*, No. 2, 2 p., 1934. ISIS

Crouse, Nellis M. The search for the Northwest passage. VI + 533 p., 4 pl., 1 map. New York, Columbia Univ. Press., 1934. ISIS

Reviewed by C. A. KOFOID, *Isis* 24, 185-86, 1935.

Heathcote, N. H. de Vaudrey. Early nautical charts. *Annals of science* 1, 13-28, 1 pl., 3 fig., 1936. ISIS

Henderson, G. C. The discoverers of the Fiji Islands, TASMAN, COOK BLIGH, WILSON, BELLINGSHAUSEN. XVIII + 324 p., 44 pl., 9 charts, 1 map. London, MURRAY, 1933. ISIS

Reviewed by C. A. KOFOID, *Isis* 24, 184-85, 1935.

The romance of exploration and emergency first-aid from STANLEY to BYRD. 160 p., 59 ills. New York, Burroughs Wellcome, 1934. ISIS

An illustrated handbook of an exhibit at the Century of progress fair at Chicago with accounts and illustrations of the medical outfits carried by pioneers, explorers and aviators in scientific expeditions into polar and tropical regions, including portraits, and signatures. C. A. K.

32. — GEOLOGY, MINERALOGY, PALAEONTOLOGY, MINING

(For palaeobotany, palaeozoology and palaeoanthropology, see respectively, 28. botany, 29. zoology and 39. prehistory)

Larke, Sir William J. Iron and steel. *Nature* 136, 19-26, 1935. ISIS

Friday evening discourse delivered at the Royal Institution on March 22. Includes historical summary. G. S.

Pabst, Adolf. The development of crystallography. *The mineralogist* 4, 8 p., 1936. ISIS

33. — METEOROLOGY, CLIMATOLOGY, AND TERRESTRIAL PHYSICS

Hellmann, G. Die Entwicklung der meteorologischen Beobachtungen bis zum Ende des XVIII. Jahrhunderts. *Abhandlungen der preussischen Akademie der Wissenschaften*, physikalisch-mathematische Klasse, Nr. 1, 48 p., Berlin, 1927. ISIS

Shaw, Sir Napier. The drama of weather. XIV+269 p., 92 fig. New York, MACMILLAN, 1933. ISIS

Reviewed by C. A. KOFOID, *Isis* 24, 186-88, 1935.

VI. — ANTHROPOLOGICAL AND HISTORICAL SCIENCES
(Knowledge of man, past and present)

34. — ANATOMY

Nebel, Werner. Zur Geschichte der Herzdarstellung. *Sudhoffs Archiv für Geschichte der Medizin* 28, 279-95, 30 fig., 1935. ISIS

Schumacker, Harris B. ,jr. The early history of the adrenal glands. With particular reference to theories of function. *Bulletin of the institute of the history of medicine* 4, 39-56, 1936. ISIS

The story begins in 1563 with BARTHOLOMAEUS EUSTACHIUS. G. S.

39. — PREHISTORY

Hock, Georg. Ein Beitrag zur vorgeschichtlichen Technik. *Schumacher-Festschrift*, 80-3, 3 fig., Mainz, 1930. ISIS

About hand corn milling. G. S.

Sarton, George. Prehistoric representation and conception of pregnancy (*Isis* 22, 529, pl. 21, 1935). *Answer* no. 47. *Isis* 24, 113, 1935. ISIS

Seger, Hans. Die Anfänge des Dreiperioden-Systems. *Schumacher-Festschrift* 3-7, Mainz, 1930. ISIS

" Die Aufstellung des Dreiperioden-Systems, man könnte auch sagen die Entdeckung des Bronzealters, wird mit Recht als der entscheidende Schritt zur wissenschaftlichen Behandlung der vorgeschichtlichen Denkmäler

betrachtet. Weil die Dreiteilung zuerst in dem 1836 erschienenen ' Ledetraad for nordisk Oldkyndighed ' klar und deutlich ausgesprochen war, gilt dieses Jahr allgemein als das der Aufstellung und der Verfasser jenes Leitfadens CHRISTIAN JÜRGENSEN THOMSEN, als der Urheber des Systems."

40. — ETHNOLOGY

(Primitive and popular science)

Bergsøe, Paul. Metallurgy of gold and platinum among the Pre-Columbian Indians. *Nature* 137, 29, 1936. ISIS

Crawford, O. G. S. The writing of NJOYA. *Antiquity* 9, 435-42, 2 fig., 2 pl., 1935. ISIS

Apropos " of Sultan NJOYA, ruler of the Bamoun communities of the Cameroons. Perhaps his most brilliant feat was to invent an ideographic script for the Bamoun language; and then, not content with this, to convert it into an alphabetic one, and to use it for the promulgation of a code of laws and a religious or philosophical system. He died in 1932, but his alphabet is still in use."

Laignel-Lavastine, Prof. Introduction à l'étude du folklore médical. *Bull. de la soc. franç. d'hist. de la méd.* 29, 350-59, 1935. ISIS

Stamm, Edward. Die Arithmetik des primitiven Menschen. *Archeion* 17, 149-70, 1935. ISIS

Walker, Winslow M. A Caddo burial site at Natchitoches Louisiana. *Smithsonian miscellaneous collections*, 94, 15 p., 6 pl., Washington, D.C., 1935. ISIS

" One of the most important phases of current work in southern archeology consists of the location and excavation of sites that can be definitely proved to have been inhabited by known historic tribes. It is always possible that stratigraphic evidence of earlier occupations may be detected in definite relationship with such known sites. Until more is discovered concerning the nature of archeological remains that may be attributed to the Caddo, Natches, Tunica, Arkansas, Chickasaw, Choctaw, and the several Creek tribes, we shall be unable to draw conclusions as to the part their various ancestors played in the building of the mounds in the Lower Mississippi Valley known to be of pre-Columbian origin. New evidence recently brought to light may now perform this service for the Caddo of northwestern Louisiana."

41. — SUPERSTITION AND OCCULTISM

Black, George F. A list of works relating to lycanthropy. *Bulletin of the New York Public Library* 7 p., Dec. 1919. ISIS

Thomas, Ernest S. Fire-walking. *Nature* 137, 213-15, 1936.

See on same subject, *Isis*, 24, 286. ISIS.

43. — SOCIOLOGY, JURISPRUDENCE AND POSITIVE POLITY

Bentley, Arthur F. Behavior, knowledge, fact. XII+391 p. Bloomington, Ind., Principia Press, 1935. ISIS

"This book joins in systematic construction two lines of inquiry in which Dr. BENTLEY has long been engaged. The first aims at enhanced powers of observation in the social field. The second explores the linguistic conditioning of science and knowledge (*Isis* 20, 491-2). Both lead towards positive and direct methods of investigation in regions in which fictive 'mentals' and abstract 'socials' have too often been the worker's main reliance."

Brown, W. Sterry. Science—education—good citizenship. 8 p. Bloomington, Illinois, Box 145, The author, 1935. ISIS

Mayer, Joseph. The techniques, basic concepts, and preconceptions of science and their relation to social study. *Philosophy of science* 2, 431-83, 1935. ISIS

Mead, George H. (1863-1931). Mind, self and society. (Edited, with introduction, by CHARLES W. MORRIS). 401 p.+XXXVIII. University of Chicago Press, 1934. ISIS

Reviewed by ROBERT K. MERTON, *Isis* 24, 189-91, 1935.

44. — HISTORY OF CIVILIZATION

(*General history, historical methods, biography and chronology*)

Barnes, Harry Elmer. The history of western civilization. With the collaboration of HENRY DAVID. Vol. I: XXV+911 p. Vol. II: XXV+1,170 p. New York, HARCOURT, BRACE, 1935. ISIS

Dr. BARNES' volumes by and large fulfil their avowed function of providing a straightforward account of the development of Western culture. It may fairly be said that no other single work will prove as useful to the undergraduate student and layman for purposes of general orientation, particularly in view of the especially well-selected bibliography. The convictions basic to the work are, one, "that the history of civilization must be founded upon a broad perspective of time and space that cannot be secured from history alone, but must be grounded in biology, archaeology, anthropology, and sociology as well"; and two, that cultural trends must be treated as

fully as economic, political and military developments, allowing for shifting emphases upon the various civilizational elements in different epochs. In short, the work is a concrete application of the principles of the "new history." R. K. M.

(**History**). List of doctoral dissertations in history now in progress at the chief American universities, December 1935. 64 p. Division of historical research, Carnegie Institution of Washington. ISIS

Sarton, George. The Sator arepo formula. *Query* no. 52. *Isis* 24, 107, 1935. ISIS

48. — HISTORY OF PHILOSOPHY

(*See also above* 18. *Philosophy of science*)

Lapan, Arthur. On space and time as attributes of nature and forms of experience. *Philosophy of science* 3, 9-18, 1936. ISIS

Miller, David L. Things and potentiality. *Philosophy of science* 3, 19-25, 1936. ISIS

Moore, Merritt Hadden. A metaphysics of design without purpose. *Philosophy of science* 3, 1-8, 1936. ISIS

VII. — MEDICINE

50. — HISTORY, ORGANIZATION, AND PHILOSOPHY OF MEDICINE

Bragman, Louis J. Some medical pioneers of central New York. A note on the local aspects of medical history. *Medical life* 42, 639-42, 1935. ISIS

Butler, C. S. Pride of opinion and its influence upon the history of medicine. *Medical life* 42, 635-39, 1935. ISIS

Ciocco, Antonio. The historical background of the modern study of constitution. *Bulletin of the institute of the history of medicine* 4, 23-38, 1936. ISIS

Diepgen, Paul. Weltanschaulich bedingte Wandlungen in der Medizin. *Die medizinische Welt*, Nr. 51, 16 p., 1935. ISIS

Dustin, Albert. La médecine et le libre examen. *Revue de l'Université de Bruxelles* 40, 190-213, 1934-35. ISIS

Findley, Palmer. On the history of childbirth. *Medical life* 42, 632-34, 1935. ISIS

Laignel-Lavastine, Prof. Catalogue du médaillier du Professeur GILBERT dressé par Mlle DESAVIS. *Bull. de la soc. franç. d'hist. de la méd.* 29, 333-38, 1935. ISIS

Malcolm, L. W. G. The medical man as a collector in the seventeenth and eighteenth centuries. *Medical collector number, Medical life,* 42, 566-620, 1935. ISIS

(Medicine, history, Madrid congress 1935). Le dixième congrès international d'histoire de la médecine (Madrid, 22-30 septembre 1935). En marge du congrès par PAUL DELAUNAY. *Bull. de la soc. franç. d'hist. de la méd.* 29, 249-73, 309-20, 1935. ISIS

Nesbit, Louis. Physician-authors of the past and present. *Medical life* 42, 643-70, 1935. ISIS

Opuscula selecta Neerlandicorum de arte medica. Fasciculus tertius decimus, quem curatores miscellaneorum quae vocantur *Nederlandsch tijdschrift voor geneeskunde* collegerunt et ediderunt. XXXI+307 p., 20 pl. Amstelodami sumptibus societatis, 1935. ISIS

The present volume of this admirable collection every volume of which has been duly reported in *Isis* (for the previous ones see our vol. 23, 606) contains a series of consultations by Dutch physicians, fourteen in number. I give the names of each together with the date of his consilium: Master ARENT and ALBERT (1550), VESALIUS (bef. 1564), PETRUS FORESTUS (1558), JOHANNES WIER (1582 and 1583), HENRICUS A BRA (1594), JOH. VAN BEVERWIJCK, RENATUS CARTESIUS, ein Arzt in Löwen (VOPISCUS FORTUNATUS PLEMPIUS), GUY PATIN and CORN. VAN SOMEREN (1640, 1641 and 1643), HERMANNUS BOERHAAVE (1717), JOHAN CHRISTOPHORUS LUDEMAN (1741), MATTHIAS VAN GEUNS (1770), SALOMON DE MONCHY (1776), PETRUS CAMPER (1780), DIDERIK HENDRIK ORT (1848), JOHAN NICOLAAS RAMAER (1848), ANTONIUS MATHIJSEN (1870). The documents are translated into Dutch. Preface in Dutch and French by M. A. VAN ANDEL. Twenty plates. G. S.

Pina, Luiz de. Histoire de la médecine portugaise. Abrégé. 132 p., illus. à Pôrto, Enciclopédia portuguesa, 1934 (La vraie date de publication est 1935). ISIS

L'auteur, professeur à la Faculté de médecine de Porto, avait préparé cet

abrégé pour le III[e] Congrès international des sciences (Coimbra 1934), mais l'impression ne fut terminée qu'en 1935, et je ne l'ai reçu qu'au début de 1936. Abrégé élégant et bien illustré, divisé comme suit : 1. Temps pré-historiques jusqu'à 1130 (Fondation de l'École de Santa Cruz de Coimbra); 2. 1130-1290. Institution des Estudos gerais à Lisboa : Université; 3. 1290-1504. (Statuts de l'Hôpital royal de Todos-os-Santos, à Lisboa); 4. De 1504 à 1772. Réforme des études universitaires : Marquis de POMBAL; 5. De 1772 à 1825. (Fondation des Écoles de chirurgie de Lisboa et de Pôrto); 6. 1825 jusqu'à 1900; École médico-chirurgicale. Faculté de médecine de Pôrto. Professeurs historiens de la médecine (décédés); Notes et renseignements; Bibliographie. G. S.

Rothschuh, Karl. Theoretische Medizin? Begründung ihrer Notwendigkeit in der Gegenwart und eine Umreissung des Gebietes. *Klinische Wochenschrift* 14, 11 p., 1935. ISIS

Schlueter, Robert E. Doctors who served outside the limits of medical science. ISIS

Presented before the St. Louis chapter, American Library Association, October 1928.

Schlueter, Robert E. The necessity for studying medical history. *Journal of the Missouri State Medical Association* 13, 30 p., 1916. ISIS

Schmidt, Frederick Rehm. Cosmetics and history. *Medical life* 42, 628-31, 1935. ISIS

Sigerist, Henry E. L'inquiétude actuelle dans le monde médical. *Schweizerische medizinischen Wochenschrift* 65, 12 p., 1935. ISIS

" Je suis revenu de mon voyage avec la conviction que la médecine soviétique représente une forme du service de santé adaptée aux conditions de la société industrielle de nos jours, et que ce qui se passe en ce moment, en U. R. S. S. est le commencement d'une nouvelle période de l'histoire de la médecine."

Van Wersch, L.; Wolff, W. H. Artsen en postzegels. *Bijdragen tot de geschiedenis der geneeskunde* 16, 30-31, 21 fig., 1936. ISIS

Portraits of physicians on postage stamps. G. S.

(Zakheim, Bernard). The opportunity for pictorial art in modern medicine : an example in San Francisco. 16 p. (no date 1936?) ISIS

Apropos of the painter BERNARD ZAKHEIM. G. S.

51. — EPIDEMIOLOGY, HISTORY OF SPECIAL DISEASES. PUBLIC HEALTH AND SOCIAL MEDICINE

Celli-Fraentzel, Anna. Le vicende spagnuole in Italia nel 500 e 600 e la malaria. *Rivista di storia delle scienze mediche* 26, 360-65, 1935. ISIS

Darmstaedter, Ernst. Ein Beitrag zur Erforschungsgeschichte der Hämoglobinämie und Hämoglobinurie. *Sudhoffs Archiv für Geschichte der Medizin* 28, 338-46, 1935. ISIS

Schnitker, Maurice A. A history of the treatment of gout. *Bulletin of the institute of the history of medicine* 4, 89-120, 1936. ISIS

Süheyl, A. Sur l'histoire de la peste en Turquie. Comptes rendus du IX[e] Congrès international d'histoire de la médecine 7 p. Bucarest, 1932. ISIS

52. — HISTORY OF HOSPITALS, OF MEDICAL TEACHING, AND OF THE MEDICAL PROFESSION. BALNEOLOGY, MEDICAL GEOGRAPHY

Freeman, Allen W. Preventive medicine in evolution. *Bulletin of the institute of the history of medicine* 4, 65-74, 1936. ISIS

Hellinga, G. "Amsterdamsche hulpziekenhuizen." *Bijdragen tot de geschiedenis der geneeskunde* 16, 21-28, 1936. ISIS

53. — PHARMACY. PHARMACOLOGY. TOXICOLOGY

Borkowsky, Ernst. Die Löwenapotheke in Naumburg an der Saale. Eine Geschichte des städt. Medizinalwesens nach den Akten des Ratsarchivs. 64 p., ills. Mittenwald (Bayern), NEMAYER, 1935. ISIS

Dausse, Les laboratoires (1834-1934). Cent ans d'expérience pharmacologique. 24 p., figs. Etampes, Imprimerie DAUSSE, 1935. ISIS

Ferchl, Fritz. Illustrierter Apotheker-Kalender 1936. Verlag. d. Deutsch. Apothekerschaft, Berlin. ISIS

Loose leaf calendar including many illustrations of historical interest. G. S.

Heischkel, Edith. Geschichte der medizinischen Verwendung des Silbers. Handbuch der experimentellen Pharmakologie 1972-76, 1932. ISIS

VIII. — EDUCATION

(the methods of accumulating, imparting and diffusing knowledge)

54. — EDUCATION

(*Generalities, methods, colleges, universities*)

Agostini, Amedeo. Matematici e fisici, direttori e professori della scuola normale superiore di Pisa. Conferenza letta nel Salone degli Stemmi il giorno 18 maggio 1934. 18 p. Pisa, Arti Grafiche Pacini Mariotti. ISIS

Payne, Fernandus ; Spieth, Evelyn Wilkinson. An open letter to college teachers. XI+380 p. Bloomington, Ind., Principia Press, 1935. ISIS

"We have undertaken to present and to discuss some of the more significant developments in higher education from the point of view of the college teacher. It is our belief that college teachers should have some acquaintance with these developments but that it would be a waste of too much time and energy for every teacher to wade through the enormous mass of educational literature, only a small portion of which is of value."

55. — ACADEMIES, SOCIETIES, CONGRESSES. NATIONAL AND INTERNATIONAL ORGANIZATION OF SCIENCE

(*Societies and congresses devoted to particular sciences are classified under those sciences. For the internal organization of science*—Isis I, 195— *see section* 17)

Gabrieli, G. Vita accademica in Roma nell' età moderna. 23 p. Rome (no date ; received 1936). ISIS

Contents : L'Accademia nella vita intellettuale moderna, in particolare nel sec. XVII. 2. Il pensiero italiano nel seicento. 3. La vita in Roma seicento. 4. L'Accademia umanistica in Roma, prima e dopo il Sacco. 5. Vita accademica romana nel sec. XVII : decadimento e splendida alba di rinascita. 6. Vari tipi e fisonomie di Accademie romane : dalla Pomponiana alla R. Accademia d'Italia.

57. — MUSEOLOGY

(*Museums and collections*)

Lemoine, Paul. Le Muséum national d'histoire naturelle. Paris, *Natural history magazine* 5, 4-19, 1935. ISIS

Historical sketch from 1626, with illustrations. C. W. A.

59. — CATALOGUES OF SECOND-HAND BOOKS ON THE HISTORY AND PHILOSOPHY OF SCIENCE

Many catalogues of second-hand books are so interesting and so full of valuable information that we shall henceforth register them in this section, together with other lists of a similar nature, such as catalogues of scientific medals and prints. When applying to the publishers of these catalogues for a copy, please mention *Isis*.

L'art ancien, S. A. Early science, literature, geography. Catalogue 19, 112 p., 150 items, illus. Zurich, 1936 (received Dec. 1935). ISIS

Fock, Gustav. Angewandte Botanik. Landwirtschaft. Kultur-Pflanzen. Obst-u. Gartenbau. Forstwissenschaft. Offizinelle Pflanzen. Antiquariatskatalog Nr. 705, 96 p. Leipzig C 1, Sternwartenstr. 8, 1935. ISIS

Goldschmidt, E. P. Mediaeval literature. List no. 20, 36 p. 295 items. London, W.1, 45, Old Bond St. (received Feb. 1936). ISIS

Goldschmidt, E. P. Old medicine including a number of French XIXth century medical classics. List no. 19, 28 p., 251 items. London, W.1, 45, Old Bond St., (received Dec. 1935). ISIS

Goldschmidt, E. P. Rare & valuable books. Catalogue 39, 73 p., 163 items. London, W.1, 45 Old Bond St. (received Dec. 1935). ISIS

Nijhoff, Martinus. An important collection of books on philosophy. No. 595, 138 p., 4644 items. The Hague, 1935. ISIS

Nourry, E. Voyages anciens et modernes. No. 271 du Bibliophile français. 92 p., 1050 items. Paris, Ve, 62, rue des Ecoles, 1936. ISIS

Quaritch, Bernard. A catalogue of books on biology, general zoology (including conchology, crustacea, entomology, ichthyology, mammalia, ornithology and reptilia) palaeontology and geology. No. 514. 92 p., 1282 items. London, 11 Grafton, New Bond St., 1936. ISIS

59. — MEMORIA TECHNICA

Critical bibliography no. 46. *Isis*, vol. 25, 520-613, 1936. ISIS

This note is published at the end of our bibliography solely for the

convenience of the scholars who cut the whole or part of it, attach extracts to catalogue cards and classify them. By adding this note to the others they will be able to find out rapidly whether this particular bibliography has been analyzed or not.

Isis no. 67 (vol. 24, 1, 303 p., 1 pl., 7 fig.). Bruges, 1935. ISIS

This number is analyzed in the 46th Critical Bibliography. Every previous number has been analyzed in previous bibliographies. G. S.

60. — ERRATA. Series 36.

(*For previous errata see* Isis 25, 307).

Si quis Argi oculos habere posset eosque omnes diligentissime ac accuratissime intenderet in singulos versus, multa tamen eum inter corrigendum effugerent. JOANNES MATTHAEUS (Wittenberg 1619).

ISIS

Vol. 18, 337, l. 12. Read ERNST H. F. MEYER, not E. H. J.

Vol. 23, 192, note 64.3, l. 3. The second Krakowie should be replaced by Krakow.

261. Read ROBERT T. GUNTHER, not GUNTER.

578. Note SHERRINGTON. Read 36000, not 3600.

579. First note. A world (not word) list.

Vol. 24, 155, l. 12. Read works, not words.

294. *Errata series* 33 (not 32).

OSIRIS, vol. I

Par une erreur de transcription du manuscrit de l'article, " Les mathématiques dans le Journal des savants," pp. 568-83, on a imprimé dans les pages 568, 570 et 579, l'année 1666, comme première année du Journal. En réalité, il faut lire 1665 (comme il est écrit dans d'autres endroits de l'article (p. 583).

A la page 577 lire mult 6 ± 1 (plus ou moins) et mult 3 ± 1 (plus ou moins) (4^e et 1^e ligne d'en bas). P. S.

P. 585, line 15, for " Solstice " read " Solstace " (sic).

P. 587, line 23, for " (SAMUEL, A. B. 1748) " read " (Harvard, A. B. 1748)."

line 2, (from foot) for " B. A." read " A. B."

P. 590, line 10 (from foot), for Harvard University read Harvard College.

P. 593, line 3, for cdd read *cdd.*
P. 603, line 21, insert △ before AEC and DEC. L. G. S.

A few other misprints are not mentioned in these errata because they are too obvious to cause any error or confusion. I wish to express my thankfulness to the readers who take the trouble to make the above-mentioned corrections in their sets of *Isis*, *Osiris*, and the *Introduction*. I would advise them, after having accomplished that little task, to write their initials at the bottom of this note to indicate that these and the previous errata have been taken into account.

These and the previous errata have been corrected by...

Index of Authors Included in the Forty-sixth Bibliography

The Roman figures followed by (1) or (2) refer to the centurial classification (Part I); thus Aegerter, E., XIII(2) means that a paper by Aegerter is listed under thirteenth century, second half.

The Arabic figures refer to the historical and to the systematic classification (Parts II and III) which are subdivided in sections numbered consecutively from 1 to 60. For instance, Eliade, M., 9, indicates that a paper by Eliade is listed in section 9 (India); Fettweis, E., 16, indicates that a paper by Fettweis is listed in section 16 (History of science).

March 1936. FRANCES SIEGEL.

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History of Science Society

REPORTS FOR 1935

REPORT OF THE SECRETARY-TREASURER

To the President and Council of the History of Science Society.

I herewith take pleasure in presenting the twelfth annual report of the Secretary and Treasurer of the Society.

A brief summary of the financial statement is as follows, and a detailed report is herewith attached.

The total membership of the Society for 1935, including those paying dues to the Brussels office and new members, is 669; delinquents, resignations and deaths, 75. The total money received is $2,751.00 including $355.00 from those elected as patrons. The total expenditure is $2,741.50, including $1,904.00 contribution to *Isis*.

It will be noted that we are still suffering greatly from nonpayment of dues, as a consequence of the depression. In order that the Society may go forward, it is an absolute necessity that a constant effort be made to elect new members to offset this loss. From a statistical study of the gain and loss of members during the past four years (depression years), it seems apparent that we have come to a stationary point. Therefore, should the economic situation improve, as there are indications that it will, it is confidently hoped that the next four years will see the Society enlarge itself, both in membership and in influence.

The expense of keeping the membership from falling off has been a little larger this year than in the past, and consequently further preparations are being made to secure new institutional members. This work has been in the hands of Miss Omo Greener, first assistant, who has drafted special letters, under my direction. The method of seeking new institutional members is based upon a study of the curricula listed in the latest university and college catalogues. Our purpose is to seek

information as to what institutions are giving courses in the history of science, and having this information, we address a letter to the librarian, calling his attention to these courses, and the purpose and value of our official publication as a desirable source and reference guide for the use of students and professors in these courses. In addition we are seeking to interest other institutions, such as museums and state libraries. We also write to institutions who are subscribing to *Isis* in order to call their attention to the difference between the subscription price and membership dues in the Society, as well as to other advantages of membership in the Society. We have been quite successful in this last undertaking. Our efforts in the case of individual scholars are also being constantly stressed, particularly through the invitational form. The correspondence required by this work, together with that of the unusually numerous requests for financial aid in publishing books, forms one of the principal tasks of this office. In addition to this work, a large number of letters have been acknowledged, giving information to members concerning the new publication proposed by Dr. SARTON, namely, *Osiris*. We might mention another large burden this office carries, that of acknowledging letters from railroad companies, hotels, and Chamber of Commerce secretaries. Each desires to know where we are to hold our next annual meeting, the possible number of members attending, and a copy of the membership list.

The new membership directory will be made ready for the printer during January. The delay for the year has been due to the desire to include information concerning those who have become patrons of the Society.

Some two hundred letters were prepared and sent to those most interested in the Society's work and future, inviting them to become patrons by paying an additional $10.00 per year for three years. We are pleased to report that 42 members have responded to our request. Some have paid for 1935, and others will begin in 1936. This money has been devoted entirely to the new membership drive.

Dr. SARTON has had prepared a brief table of contents for Volume 1 to 20 of *Isis*. Two hundred copies were sent to this office with instructions that only those who are members in good standing were to receive a copy gratis. 105 copies have been sent out thus far. We have also sent out an unusually large number of sample copies of *Isis*, particularly to foreign libraries. Special letters were prepared and sample copies sent to all the national libraries and institutional libraries in Australia, New Zealand, China, Mexico, Brazil, and South Africa. The response to these has not been as favorable as we had hoped.

The Society has been invited to be represented on three unusual occasions. The most notable of these was the Second General Assembly of the Pan American Institute of Geography and History held here in Washington, October 14 to 19, 1935. The fact that this Congress was held in Washington made it possible to have delegates attend. The President appointed Dr. H. W. TYLER and the Secretary.

The Society's work has grown to such an extent that the Secretary has found it necessary to increase his time in order to take care of this development. He was fortunate in securing the assistance of Miss LAVADA HUDGENS, a recent graduate of the University of California.

The President, Dr. C. A. BROWNE, was called out of the United States from July to November. Dr. CHAUNCEY D. LEAKE was asked to officiate in his absence, and at the same time, to perform the work of Chairman of the program committee.

We regret to state that the Society has suffered the loss of a number of its older members, particularly Foundation Members. The Secretary is not always aware of this loss until the end of the year, or as he happens to see their obituary notices in *the New York Times*, *Science*, or *Nature*. The most notable of these was Dr. MICHAEL I. PUPIN, the distinguished inventor and professor of electrical engineering at Columbia University. Dr. PUPIN died March 12, 1935. On April 19, Dr. FIELDING H. GARRISON, the distinguished medical historian and librarian of the William H. Welch Medical Library of Johns Hopkins University, died in Baltimore. Dr. GARRISON served as a member of the Council for one term, and chairman of the program committee in 1928. Dr. CHARLES ST. JOHN, outstanding as an astronomer at Mt. Wilson Observatory, died April 27th. Dr. St. JOHN was never a member of the Council, but had expressed to the Secretary his very keen interest in the work of this Society. He maintained his membership from 1924 until his death.

Dr. EDWARD S. DANA, mineralogist and distinguished editor of the *American Journal of Science*, died June 16 in New Haven. Dr. DANA, professor emeritus of Yale University since 1917 was a Foundation member, and continued his membership until his death.

Dr. JAMES H. BREASTED, the very distinguished oriental scholar of the University of Chicago, died in New York on December 2nd. Dr. BREASTED served as first vice-president for two terms, and president in 1926.

Respectfully submitted,

FREDERICK E. BRASCH.

Money Received

Money received from dues 1935	$2275.00
Money received from dues 1934	105.00
Money received from Patrons (35)	355.00
Balance, 1934	16.00
	$2751.00

Expenditure

Contribution to *Isis*	$1904.00
Secretarial aid	456.00
Printing and mimeographing	95.25
American Council of Learned Societies, dues	25.00
Transportation	52.00
Postage and express	93.75
Office supplies	15.50
Honorarium	100.00
	$2741.50

* * *

Dear Mr. President,

I wish to report on behalf of the Committee for the publication of a glossary of Latin mediaeval, scientific and medical terms which was appointed at last year's annual meeting of the History of Science Society.

The Committee is not yet able to present a definite recommendation at the present time. There can be no doubt that such a glossary is greatly wanted, but one should not overlook the difficulties of such an undertaking. I had hoped last year that our Institute would be able to appoint a young philologist who would have devoted most of his time to the preparation of such a glossary, and who would have coordinated the work done by other workers in the field. The budget of our Institute, however, was so seriously reduced that we can not consider increasing our staff. I then hoped the American Council of Learned Societies could be approached for a grant, but the financial situation of the Council is such at the present time that it will not be able to consider any new project in the coming year.

I hesitate to start such a vast undertaking without a definite plan, and it seems that such a plan can not be made at the present time. I therefore respectfully request that the Committee be given one more

year to study the question. The American Council of Learned Societies will appoint a special committee of delegates of all the bodies interested in mediaeval lexicography. I will be on this committee ex officio, and I believe that in a year I will be able to present a definite recommendation to the board of the History of Science Society.

Very sincerely yours,

HENRY E. SIGERIST.

THE HISTORY OF SCIENCE SOCIETY

(COUNCIL RECORD)

Meeting January 2, 1936, 4:50 p. m.

The Council of the History of Science Society met in the lecture room, Parlor A of the Mayfair Hotel, St. Louis, with Dr. C. A. BROWNE, President, in the chair. The following members of the Council were present :

Dr. LEAKE, Dr. KARPINSKI, Dr. MORRIS, Dr. BROWN, Dr. WATSON DAVIS, Dr. HAROLD T. DAVIS, Dr. DAINS, Dr. SARTON, and F. E. BRASCH, Acting Recording Secretary.

The minutes of the last meeting were read and approved.

The following officers were declared elected to the Council to serve until December, 1938 :

Dr. JOHN F. FULTON of Yale University, Dr. F. OTTO KOENIG, Jr., of Stanford University, Dr. ARTHUR J. HOPKINS, Amherst College, Dr. ARNO B. LUCKHARDT of Chicago University, and Dr. HARCOURT BROWN of Washington University.

Following the Council election, the resignation of Dr. BROWNE, who asked to be relieved of the office because of ill health, was accepted. At the request of the President, the Secretary was asked to place a motion before the Council that Dr. CHAUNCEY D. LEAKE, First Vice-President, be appointed to serve the balance of Dr. BROWNE's term, namely, for 1936. The motion was carried. The Secretary then placed a second motion, namely, that the Council advance the Second Vice-President, Dr. HENRY E. SIGERIST, to the first vice-presidency. This necessitated the election of a Second Vice-President. Accordingly, the Secretary placed a nomination for Dr. L. C. KARPINSKI, whom the Council elected.

The Secretary placed a nomination for the re-election of Dr. LAO G. SIMONS to the office of Recording Secretary, which was accepted by the Council.

Dr. CHAUNCEY D. LEAKE nominated Mr. F. E. BRASCH for the office of Corresponding Secretary-Treasurer, and he was accordingly re-elected to that office.

The Corresponding Secretary-Treasurer read his report, which was discussed and approved.

Dr. GEORGE SARTON, editor of *Isis*, made a verbal report of the editorial work of *Isis* during the past year. This was followed by a lengthy discussion of the new publication, *Osiris*.

The Council requested the Secretary to extend a vote of thanks to Dr. KUNTZ and the Academy of Science of St. Louis for their cordial hospitality and efficient arrangement of the program and the meeting place.

The President, Dr. BROWNE, appointed a committee of three to draft resolutions expressing the Society's regret and great sense of loss at the passing of Dr. JAMES H. BREASTED, former president of the Society. This committee consisted of Dr. LEAKE, Dr. SARTON, and the Secretary.

Two items of unfinished business were deferred, namely, the reading of the report of Dr. BRETT, chairman of the book fund committee, and that of Dr. SIGERIST, chairman of the committee for the publication of a glossary of Latin mediaeval, scientific and medical terms, with instructions that copies of these should be sent to the members of the Council by mail.

Owing to a dinner arrangement, the Council adjourned at six-thirty

LAO G. SIMONS.

Recording Secretary.

ISIS REPORT FOR 1935

This report covers no. 63 (p. 217 to end), and nos. 64 to 67, that is, a total of 1259 pages with 15 pl., 97 fig. and facsim., including 25 memoirs, 52 shorter items, 123 reviews, 2460 bibliographical notes.

SUMMARY OF ACCOUNTS

Expenditures			*Receipts*	
1. Printing	2614.26		HSS	1904.00
2. Plates, figs.	215.18	2829.44	CI	1200.00
Mailing		657.88	Sales Bruges	555.21
Royalties			Sales Brussels	37.98
Reprints	199.13		Friends	30.00
Gifts	12.18	211.31	Contributor	2.25
Editorial				
Cambridge off.	301.32			3729.44
Brussels off.	332.11			
To St. Louis	100.00	733.43	Editor's loss	702.62
		4432.06		4432.06

The cost of printing (items 1 and 2) averaged $2.25 per page, the total cost averaged $3.52 per page.

N.B.—This account is not entirely exact as I have not taken into account the continual fluctuations of the exchange. For the sake of simplification Belgian francs have been converted into dollars at the single rate of 26 to 1.

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OSIRIS

SERIES OF SUPPLEMENTARY VOLUMES TO ISIS

EDITED BY GEORGE SARTON, D. Sc.

The first volume containing a collection of essays on the history of mathematics and on the history of science appeared in January 1936. The edition is limited and relatively small. Libraries wishing to secure a copy should send their subscription to this volume (or a continuation order for the whole series) to

Mr. F. E. BRASCH,
Secretary of the HSS, Library of Congress,
Washington, D. C.

The price will be $ 6 per volume of the average size of *Isis* volumes ($ 5 to members of the H.S.S.).

***

The vols. of *Osiris* will contain in general series of articles devoted to a single subject, and also longer memoirs. It is proposed to publish one volume a year, or exceptionally two, but not more.

Isis will continue to be a quarterly journal containing shorter articles, reviews, notes and correspondence and critical bibliographies. The removal of the longer articles to *Osiris* will increase the variety and attractiveness of *Isis*, but on account of previous obligations this reform will not be completed until 1936.

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